THURSDAY, JANUARY 18, 1877

FERMENTATION[1]

II.

Études sur la Bière. Par M. L. Pasteur. (Paris: Gauthier-Villars.)

WHAT is fermentation? Such is the important question of which we have now to seek the solution. It is necessarily impossible within the scope of a brief article to enter into an examination of the numerous theories propounded, yet a few words of explanation are needed in order that we may the more clearly understand what it is that Pasteur has done, and what is the real bearing of his answer to the question not only on fermentation, but on many a disease which flesh is heir to.

According to Willis and Stahl, to whom we are indebted for the first philosophical attempt at explanation, fermentation was due to a peculiar motion communicated from a decaying body to another substance, by which a similar degrading action was set up, so that complex molecules became less complex. This idea was subsequently taken up and developed by Gay-Lussac, Liebig, and others, who maintained that the decomposition of albuminous bodies produced the molecular disturbance by which sugar was broken up into alcohol and carbonic acid. Thus the molecular disturbance produced by decay of nitrogenous matter in a fitting liquid gave rise to lactic and butyric acids and other products.

The contact theory of Berzelius and Mitscherlich belonged to a period in the history of chemistry when catalysis was constantly employed to explain the unknown, and need not here be further alluded to.

Cagniard de Latour, in 1837, first proved that yeast is composed of living cells; this was confirmed by the almost contemporaneous observations of Schwann and Kützing, and subsequently by Turpin and others. The subject, however, remained in much obscurity until Pasteur commenced his investigations on the nature of ferments; these have been carried on for a period of twenty years, the results obtained being communicated to the French Academy in 1862 and subsequent years and are now, in so far as they concern the brewer, summed up in the important work before us. The theory of molecular disturbance produced by putrefaction, so energetically maintained by Liebig, may be considered vanquished on all points. M. Pasteur, from his researches, has proved incontestably the two following propositions:—

1. *Every diseased alteration in the quality of beer coincides with the development of microscopic organisms foreign to the nature of beer, properly so called.*

2. *The absence of alteration of beer wort and of beer coincides with the absence of foreign organisms.*

The first proposition M. Pasteur has amply proved from hundreds of examinations of beer undergoing diseased action; in no one case did he find the sediment of such beer to consist solely of the globular or ovoid alcoholic yeast cells, but of a more or less intermixture with the various ferments of disease already described by him with great minuteness in his "Études sur le Vin." His second proposition is a necessary corollary of the first.

[1] Continued from p. 216.

We cannot do better than follow our author in some of his researches by which he has demonstrated the truth of these propositions. M. Pasteur, by boiling animal and vegetable infusions—it is not necessary in all cases to use so high a temperature—and then, by cooling them under rigid precautions against the introduction of germs from the air, has shown that they are then unacted upon by oxygen, at least that no putrefaction or fermentation ensues.

The temperature to which a liquid must be heated in order to ensure against subsequent decomposition varies with its nature. Thus while 50° C. is sufficient to destroy the germs in vinegar, malt infusion must be heated to 90° C., and milk to 110° C., and others require even higher temperatures. Blood and urine heated in Pasteur's flasks and cooled under conditions precluding the entrance of germs from the air undergo no alteration even when kept for weeks at a temperature of 20° C. in contact with pure air. Mere oxidation therefore is not the cause of fermentation and putrescence. It is unnecessary to refer to the exceptions taken by many experimentalists to Pasteur's conclusions, the great experimental skill required and the rigid precautions to be taken to secure success amply explain why others less habile than Pasteur have obtained conflicting evidence. Two of the ablest of his opponents, Doctors Brefeld and Traube, have recently retracted their previous objections to Pasteur's results, and now unhesitatingly adopt his views on Fermentation. Allusion has already been made to the fact that the brewer occasionally, and the wine grower invariably, leaves the saccharine liquid to spontaneous fermentation; it is many years since Pasteur first demonstrated that the dust on the skin of the grape contained the small organisms necessary for vinous fermentation, and that when these were destroyed or removed no fermentation took place. Thus the juice heated in a Pasteur flask with the usual precautions against the admission of germ-laden air did not undergo fermentation when freely exposed to germ-free air, but did so readily when a portion of the dust of the skin was added. If this dust, however, was removed by a few drops of water and then boiled previously to being added to the must no fermentation took place. Hence the dust on the skin contained the ferments, and M. Pasteur has demonstrated their nature and their distinguishing features.

In the case of boiling beer wort there are necessarily no living organisms, and therefore, as Pasteur has shown, there is no change when the wort is allowed to cool in a vessel to which only pure air has access. If, however, the cooled wort be exposed to air, ferments of various kinds, *e.g.*, *Saccharomyces cerevisiæ* (though rarely), *Sacchoromyces pastorianus*, and *apiculatus*, and other alcoholic ferments, fall into the liquid; at the same time, however, attended by more or less of the lactic and butyric ferments and other organisms of disease. In a brewery where other fermentations are proceeding, doubtless the number of alcoholic ferments will be greater and the injurious bacteria less than in other localities; still in any case the beer when finished must be very inferior, owing to the large quantities of acetic, lactic, and butyric acids, and other products of putrefactive change. M. Pasteur, having satisfactorily demonstrated that alcoholic fermentation was due to the action of certain organisms

living and reproducing in a saccharine liquid, the question arose whether the common *Penicillium glaucus* and the *Aspergillus glaucus* could be transformed into the true alcoholic ferments of beer or of wine, and the still wider question of the conversion of one ferment into another; a question of vital importance to the brewer, since, if this theory of the conversion of one kind of ferment into another were proved to be true, the hope of obtaining greater power over the results of his process would be dashed to the ground, or at any rate such power would only be obtained in the distant future. In his researches upon this question, M. Pasteur availed himself of the liquid proposed by his pupil, M. Raulin (p. 89), *e.g* :—

Water	1,500	parts.
Cane sugar	70	"
Tartaric acid	4	"
Nitrate of ammonia	4	"
Phosphate of ammonia ...	0·6	"

We must refer the reader to M. Pasteur's book for the full directions of procedure and the precautions to be taken in order to avoid the introduction of mixed organisms. No one can read this portion of his work without being greatly impressed by the author's wonderful ability in detecting and overcoming difficulties and thereby removing sources of error which have led so many to erroneous conclusions. We may briefly sum up this part of his work by stating that in no case where such necessary precautions were taken did he ever find that the penicillium changed to alcoholic yeast or to a mycoderma, or that yeast gave rise to vibrios, or that mycoderma aceti became yeast. M. Pasteur himself at one time thought he had detected the conversion of the mycoderma vini into a true alcoholic ferment; in this, however, he now finds he was in error, and that more rigorous precautions fail to support his original supposition.

In his experiments with mycoderma aceti and mycoderma vini carried out with his usual marvellous ingenuity and attention to details, he has shown that these organisms in contact with the air burn up the sugar of the liquid upon which they rest; and so far from alcohol being produced in quantities that may be detected, the mycoderma vini completely burns up any alcohol previously existing in the liquid. When submerged in the liquid, though life is far less active, they continue to exist for a time, undergoing structural changes, obtaining the necessary oxygen from the sugar, and producing alcohol, as in the case of the penicillium glaucus and aspergillus glaucus under similar conditions of submersion. We must admit, with Pasteur, that the production of alcohol and carbonic acid from sugar, in other words, alcoholic fermentation, is a chemical act attending the life of cells the moment they are removed from the influence of free oxygen, and are submerged in a saccharine liquid capable of yielding oxygen and heat by its decomposition. This alcohol-producing character becomes, therefore, not the isolated property of this or that organism, but a general function of a living cell, when removed from the air and compelled to obtain the necessary oxygen by the decomposition of its food. The duration of life and the production of alcohol will vary with the power of the cell to reproduce its kind under these submerged conditions. I have already referred to the production of alcohol and carbonic acid when growing malt is placed in an air-tight vessel. Under such circumstances alcohol and a large amount of carbonic acid are for a long time produced, ultimately the moist mass becomes increasingly acid, the production of alcohol ceasing and acetic and other acids being formed attended with a strong etherial odour. When first noticed by the writer in the year 1873 he was unaware of M. Pasteur's previous conclusions as to the action of vegetable cells. Messrs. Lechartier and Bellamy in 1874 published their valuable researches, upon which they had been engaged for some time, and they proved incontestably that the cells of fruits possessed the power, when removed from free oxygen, of obtaining this gas by the decomposition of sugar; alcohol and carbonic acid gas being produced, though not in the ratio found in true alcoholic fermentation. We thus learn from our author's researches, amply confirmed by those of Lechartier and Bellamy, that active living cells, when removed from the influence of free oxygen, and when placed under conditions where they must obtain it from saccharine materials, for a time continue to exist, producing alcohol and carbonic acid. Those, such as the cells of fruits and grain, which cannot reproduce under these conditions, soon die, and the amount of alcohol produced is but small; on the other hand those cells which can reproduce by germination become true ferments, and their action only ceases when the original reproductive energy due to their previous aërial condition also ceases. Thus when the *mucor racemosus* was submerged in a saccharine liquid it was found that the alcoholic fermentation was at first active and then finally ceased, the cells being deformed in contour, full of granulations, and to all appearance dead. The introduction of a little pure air, however, reinvigorated the apparently dead organism, and again—for a time—alcoholic fermentation was produced. Free oxygen therefore endows these simple cell-plants with an energy which enables them for a time, longer or shorter, to exist without it by obtaining the necessary oxygen from their food. I have said *for a time*, because the mucor racemosus, or the mycoderma submerged in a liquid soon lose their activity and cease to act, the true yeast ferments under the same conditions being enabled for a much longer period to reproduce and carry on their vital functions; even with these, however, Pasteur has proved the necessity of periodical aëration so as again to place them under their normal aërial condition, a fact long known to those English brewers who employ the method of *rousing* to stimulate the activity of the yeast. Pasteur's investigations on fermentation have convincingly proved—at least to most minds—the intenability of a *peculiar motion* and also of *spontaneous generation* as being the true cause of these interesting phenomena.

In addition to a continued life without free oxygen which the yeast cell manifests, there is another feature—exceptional in character—which it possesses, and that is, that its growth is not commensurate with the sugar decomposed. For a given weight of yeast formed one may have ten, twenty, or one hundred times its weight of sugar decomposed. It may be of interest to quote here two experiments—out of many—bearing on this question and also on the influence of dissolved oxygen in a

saccharine liquid. M. Pasteur took two flasks partially filled with a liquid containing in each case 150 grammes of sugar; the one (*a*) was almost completely deprived of air, the other (*b*) contained air. A mere trace of yeast (species, *Saccharomyces pastorianus*) was added to each. The fermentation in *a* was sluggish, and after nineteen days, when the experiment was closed, there was still a slight evolution of carbonic acid gas; in *b* the fermentation was active, and ceased entirely on the ninth day. The weight of yeast formed was determined in both cases, as also that of the sugar left undecomposed; these were the results:—

a.	Weight of yeast formed ...	1·368 grammes.
	Sugar undecomposed	4·600 „
b.	Weight of yeast formed ...	1·970 „
	Sugar undecomposed	*nil.*

In *b*, therefore, though the liquid was far from being saturated with air, the decomposition of the sugar was completed in eight days, whereas in *a*, even at the end of nineteen days, there was still some sugar left. The weight of yeast formed was as 1 to 76 of sugar decomposed in *b*, and only as 1 to 89 in *a*. In another experiment on a sugar solution completely deprived of air, the whole of the sugar was not decomposed even at the end of three months, the yeast produced was deformed in appearance, and the ratio of yeast to alcohol produced was as 1 to 176. Reversing the experiment so as to obtain a thorough and constant saturation of the liquid with air, the ratio of yeast formed to the alcohol was as high as 1 to 4. In this latter case the yeast acted more as a mycoderm or as a mould than as a true ferment. We may sum up the bearing of the facts elucidated by Pasteur, by the statement that, within given limits defined in Pasteur's experiments, *the production of yeast is directly, and that of alcohol inversely, as the consumption of free oxygen.*

M. Pasteur having demonstrated that the alterations in the yeast, in the wort, and in the beer, are due to the action of microscopic organisms other than the true yeast cells, and that these ferments of disease are killed at a high temperature, it follows that if a boiling wort be cooled under conditions which preclude the entrance of these germs, and if fermented with pure yeast, a beer will be obtained which, so long as not exposed to germ-laden air, must remain unchanged for an indefinite time. M. Pasteur has conferred an additional favour on the practical man by designing an apparatus by which these conditions may be secured, and has carried on his process of fermentation on a large experimental scale in several French breweries with much success so far as flavour and soundness of product are concerned. The general adoption of new and costly appliances must necessarily be slow. Nor is it essential that his suggestions should be in all cases carried out in their entirety. The intelligent brewer who thoroughly masters the key to sound and unsound fermentation will be enabled to secure the one and avoid the other without replacing costly appliances by others vastly more so. To do this, however, the microscope must be in daily use in order to cultivate a purer and purer yeast crop, and his technical processes of skimming and cleansing must be more and more directed by this invaluable instrument. The selection and preservation of yeast, the cultivation of it and the gradual elimination of diseased ferments will henceforth be the object of well-guided efforts, and not of mere chance, as heretofore. The technical reader will do well to read and re-read the work before us; as he becomes master of its method of investigation and of the results obtained, so will he master many of the difficulties of his art.

Some suggestions are given (p. 224, *et seq.*) on the purification of yeast of interest to the brewer as well as to the experimentalist. It would lengthen this notice too much to give the details of the process; it will suffice here to state that the author recommends the use of a weak solution of sugar rendered slightly acid with tartaric acid. In some cases he employs in addition a trace of carbolic acid. Such a liquid destroys some true yeast; it is, however, far more injurious to the ferments of disease. It should not be forgotten that aeration, while injurious to most ferments of disease (mycoderma vini and aceti, of course, excepted), is a great stimulant to the Saccharomyces; hence this method may be adopted either alone or in conjunction with others suggested by him. Those interested in this matter, and especially the brewer, will do well to study carefully the work itself, they will find on this subject, as well as on many others, not alluded to here, much invaluable and suggestive information.

In concluding our brief examination of Pasteur's biological researches on fermentation, a few words on the products formed will not be out of place.

Numerous attempts have from time to time been made to express by a chemical equation the decomposition of glucose sugar by the yeast cell. Until the discovery of succinic acid by Schmidt, and of glycerine by Pasteur, the attempts made were far from being satisfactory. According to Pasteur 100 parts of cane-sugar corresponding to 105·26 parts of grape-sugar give when fermented—

Alcohol	51·11
Carbonic acid	49·42
Succinic acid	0·67
Glycerin	3·06
Matters united with ferments	1·00
	105·26

Therefore ninety-five parts of cane-sugar are broken up into carbonic acid and alcohol, one part is assimilated by the yeast, and four parts are converted into succinic acid and glycerin.

Monoyer has proposed the following equation to represent the decomposition of these four parts of sugar, *e.g.*,

$$\underset{\text{Hydrated cane-sugar.}}{4(C_{12}H_{24}O_{12})} + \underset{\text{Water.}}{6H_2O} = \underset{\text{Succinic acid.}}{2(C_4H_6O_4)} + \underset{\text{Glycerin.}}{12(C_3H_8O_3)}$$
$$+ \underset{\text{Carbonic acid.}}{4CO_2} + O_2,$$

the liberated oxygen supporting the life of the plant. It is impossible at present, however, to formulate the reactions which occur, because they vary according to the temperature, pressure, species of yeast employed, and to the nature of the saccharine liquid. M. Pasteur himself has pointed out that the proportions of succinic acid and glycerin vary in different experiments.

Mr. Horace Brown in some admirable and suggestive experiments on the influence of pressure on the products of fermentation (*Journ. Chem. Soc.*, 1872, p. 570), has shown that in alcoholic fermentation in addition to carbonic acid there is always formed a small quantity of nitrogen, hydrogen, and a hydrocarbon of the marsh

gas series; the nitrogen being evolved from the albuminous matter of the wort. By diminishing the pressure the amount of evolved hydrogen increased, and with this an increase in the amount of acetic acid and aldehyde. These products, though very small compared with the alcohol and carbonic acid, the chief resultants of ferment action are yet sufficient to account for the etherial odour of a fermenting tun. Pasteur had previously noticed the production of minute quantities of volatile acids. On electrolysing a weak aqueous solution of invert sugar, Brown obtained carbonic acid, hydrogen, and oxygen, and at the same time an appreciable quantity of aldehyde and acetic acid, together with a small quantity of formic acid. It may be that water is decomposed in fermentation in small quantities precisely as occurs in ordinary vegetation; though highly probable, we have, however, no definite facts in support of the assumption. Our present knowledge of the chemistry of fermentation is somewhat vague and general, and much remains to be done before we shall be enabled by purely physical means to decompose sugar so as to produce the results brought about by the yeast cell.

As we progress in knowledge, so does our power to imitate the products of life-action increase, and assuredly the time will arrive when alcohol will be produced by simple physical or chemical means. For many a year to come, however, we must continue to depend upon the wonderful organisms known as yeast. Their life history and action on liquids have been elucidated by the genius and patient toil of Pasteur, and he has enabled us to select such ferments as are required to produce the result desired, and hence we are no longer the sport of chance.

The brewer and wine-maker are not alone in the debt due to the illustrious Frenchman whose work we have briefly examined; we are all interested in the far wider field of germ action opened out by him, whereby many a disease of man hitherto as dark and unexplained as was fermentation, will be brought under the illuminating light of his teaching.

He who has thus shown us the key whereby we may open the locked-up secrets of nature may rest assured of the gratitude of his fellow-men, given with the greater earnestness and respectful sympathy from the knowledge that our guide has impaired health and sight in his labours for others.

France has given many a great name to the roll of fame, but none more noble or more worthily inscribed thereon than that of Pasteur. CHARLES GRAHAM

CAYLEY'S ELLIPTIC FUNCTIONS

Elementary Treatise on Elliptic Functions. By Arthur Cayley. (Cambridge: Deighton, Bell, and Co.).

THIS is a book thoroughly worthy of the great name of its author. It is difficult to know which to admire most, the grasp of the subject, the extreme simplicity of its exposition, or the neatness of its notation. It will, we think, at once take its proper place as the leading text-book on the subject.

In regard to notation, it seems to us to be thoroughly good throughout, not only in respect of the adoption of Gudermann's suggestion of the very short forms sn, cn, dn, for the sine, cosine, and elliptic radical of the amplitude of the function of the first kind, but throughout. In particular, we note an important typographical simplification in the suppression of the common denominator in long series of fractional formulæ, the denominator being given once for all, and its existence in each separate formula merely indicated by the sign of division (÷) This is a simplification, some equivalent of which we ourselves, and probably most of those who have worked at elliptic functions, have used in our private papers; but it is a new thing, and a very good thing, to see it introduced in a systematic form in a printed book.

Another very useful feature belonging to mechanical arrangement is, that the first chapter contains a general outline of the whole theory, so that its perusal enables the reader to see at a glance the plan and intention of the work. He is thus enabled at once to bring intelligent attention to bear upon his reading, instead of being distracted by the wonder as to what it is all driving at.

The intention of the work is, firstly, the direct discussion and comparison of the three forms of elliptic integral, and of the doubly periodic functions which are regarded as the direct quantities of which these integrals are inverse functions. Then the auxiliary functions Z, Η, and H are taken up in an elementary form, and after this the transformation of the elliptic functions, by division or multiplication of the primary integral, with the corresponding change of modulus and amplitude. These are very fully and clearly discussed. In particular, the connection between the transformation of the radical in the elliptic integrals, and the formulæ of multiplication, is clearly brought out. Legendre had left this as a very puzzling, although necessary, inference, which he scarcely stopped to discuss. After this comes a discussion of the *q* functions, with a further discussion of the functions H and Η, and then some miscellaneous developments.

The work is strictly confined to elliptic functions and their auxiliaries. The more general theories of Abel and Boole find no place in it, nor is there any general discussion of single and double periodicity such as forms the foundation of the work of Messrs. Briot and Bouquet. There are but few examples of the computation of particular values of the elliptic functions, and no account of general methods of computation, either of isolated values, or of tables, or of the arithmetic connected with them; nor are ultra-elliptic functions touched upon. The geometrical applications or illustrations of the elliptic integrals and functions are but meagre, and no mechanical applications are given.

The arithmetical work is quite rightly omitted. That will find a much better place in the hand-book or introduction which will doubtless accompany or follow the great tables of elliptic functions now being printed for the British Association. There is, however, one point which we think it an omission to notice, and that is the solution of the addition equation by means of auxiliary angles. (See Legendre, "Traité des Fonctions Ell.," vol. i., p. 22; or Verhulst, § 19, p. 40.) It is no defect, again, that the mechanical applications are omitted. These are better studied as they arise, as a part of mechanics rather than of analysis. But as regards geometry, we think there has been done either too much or too little. For instance, we have the usual theory of the representation of the arcs of the ellipse and hyperbola

by those functions, and we have a long disquisition on the geometrical representation of the elliptic integral of the first kind by an algebraic curve ; while there is no mention of the late John Riddle's discovery, that the arcs of the curves by which circles on the sphere are represented in Mercator's projection are directly given by, and absolutely co-extensive with, the elliptic integrals of the first kind, the amplitude being simply the longitude on the sphere. We think this quite as simple and as important as the discussion of the lemniscata. If we are to go into geometry at all, it might be as well also to make some allusion to Dr. Booth's discussion of the spherical conics, and to Mr. Roberts's integration of the Cartesians.

Then, again, we have an account of Jacobi's geometrical theorem in its original form, depending upon a family of circles having the same radical axis, while the corresponding theorem, depending upon circles having two inverse points in common, given by Chasles (see his "Géometrie Supérieure," cap. xxxi., p. 533), which much more directly represents both amplitudes and moduli, is not mentioned explicitly, although it is involved in the geometrical exposition given of Landen's theorem.

We have also been unable to find any account of Jacobi's reduction of the integral of the third kind to the form—

$$\int d\phi.\ \mathrm{E}\phi : \Delta\phi$$

The transformations of the functions are worked out with great completeness, the results being tabulated in some rather formidable-looking, but really very convenient, schedules. This part of the work is carried almost to an extreme.

On the whole the book is one of the most important contributions to mathematical literature which has appeared for a long time. It is well done, and covers ground that was previously but ill occupied. It is clearly printed, and the fact that the proof-sheets have been revised by Mr. J. W. L. Glaisher is a guarantee for the correctness of detail.

C. W. MERRIFIELD

OUR BOOK SHELF

Instruction in Photography. By Capt. Abney, R.E., F.R.S., &c., Instructor in Chemistry and Photography at the School of Military Engineering, Chatham. Third Edition. (London : Piper and Carter, Gough Square, Fleet Street, E.C., 1876.)

WE are very glad to find that Capt. Abney did not carry out the intention which he mentions in the preface of not producing another edition of his well-known "Instruction in Photography." That the little volume is widely known and appreciated is shown by the fact of its having reached a third edition, and we can only say that it well deserves its success. A photographer of the author's well-known skill and repute could not fail to be able to instruct others in his art, but when in addition he has gained large experience by continued practical teaching in such a school as that at Chatham his lessons become additionally valuable.

Capt. Abney does not enter much into theory, though he gives very good and simple accounts, illustrated by chemical equations, of the principal changes occurring during the processes described. We observe that he announces the forthcoming publication of a "Photography" among Messrs. Longmans' Text-books of Science, in which he proposes to deal more fully with the theoretical part of the subject. We shall look forward to this with considerable interest ; meanwhile, for practical instruction in the art this little book distances all competitors.

R. J. F.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Just Intonation

THE errors and oversights—in my paper in NATURE, (vol.xv. p. 159)—with which Mr. Chappell charges me, are imaginary. To make the matter clearer, the vibration numbers of a diatonic scale started from $\frac{3}{2}$ as a tonic are—

$$\frac{3}{2},\ \frac{27}{16},\ \frac{15}{8},\ 2,\ \frac{9}{4},\ \frac{5}{2},\ \frac{45}{16},\ 3.$$

In order to keep to the same part of the keyboard, let the last five notes be depressed one octave, and we get this series :—

$$1,\ \frac{9}{8},\ \frac{5}{4},\ \frac{45}{32},\ \frac{3}{2},\ \frac{27}{16},\ \frac{15}{8},\ 2,$$

where $\frac{3}{2}$ is the tonic, and 1 or 2 the subdominant. A similar explanation applies to the scale starting from $\frac{4}{3}$ as tonic. With respect to the "comma of Pythagoras," I am not aware of any "generally adopted miscalculation." *Who* was the real discoverer of that interval is a matter of no consequence ; but in a system such as the Pythagorean, which was tuned by true fifths, it would have been not only a very natural but an essential inquiry, "What definite number of fifths corresponds with another number of octaves?" This, without at all necessitating the supposition of the existence among the Greeks of instruments of an immense range in octaves, would be but an easy arithmetical calculation resulting necessarily in the conclusion that there was no exact coincidence between fifths and octaves, but that twelve fifths differed by a very small quantity from seven octaves. This small difference is therefore very aptly termed the Pythagorean comma. Now in the equal temperament system twelve fifths just coincide with seven octaves, so that the despised comma of Pythagoras is really a measure of the error of the equal temperament fifth. In fact, putting P for the comma in question—

$$\mathrm{P} = \left(\frac{3}{2}\right)^{12} 2^{-7} \therefore\ 2^{\frac{7}{12}} = \frac{3}{2}\ \mathrm{P}^{-\frac{1}{12}}$$

so that if $2\,\mathrm{N}$ be the vibration number of the lower tone of an E T fifth, that of the upper tone will be $3\,\mathrm{N}\,\mathrm{P}^{-\frac{1}{12}}$, which is in error by $3\,\mathrm{N}(1 - \mathrm{P}^{-\frac{1}{12}})$ vibrations, giving rise to a number of

$$\text{Beats} = 6\,\mathrm{N}(1 - \mathrm{P}^{-\frac{1}{12}})$$

per second in the E T fifth. Not, however, that it is necessary to allude to Pythagoras or seven octaves to get those beats.

The grounds upon which Mr. Chappell declines to accept 24, 27, 30, 32, 36, 40, 45, 48, as representing the vibration numbers of the diatonic scale are not very clear, certainly ; and repudiating these, he can of course have no sympathy with Colin Brown's keyboard.

To revert shortly to this, the subject of my previous communication,—in his new and very interesting work on "Temperament," Mr. Bosanquet has given a description of Colin Brown's keyboard, but in so peculiar a manner that it is really difficult to recognise the instrument at all, and neither its elegance nor simplicity are brought out as I think they should be.

A. R. CLARKE

Ordnance Survey, Southampton, January 9

South Polar Depression of the Barometer

I THINK it probable that on this subject Mr. Murphy's views and my own might have appeared more in harmony if we had neither of us expressed them with so much brevity. In my letter on Ocean Currents in NATURE, vol. xv. p. 157, I was incidentally led to speak of the barometric depression round the South as greater than that round the North Pole. In speaking

of this superiority as "mainly due to superior evaporation in the water hemisphere generally," it did not occur to me that I could be misunderstood to mean that the excessive depression in high south latitudes is due to excessive evaporation taking place *within those latitudes*, an idea which, with Mr. Murphy, I regard as absurd.

The large areas of depression which the American meteorologists have termed the "Polar Cyclones" appear, on examination, to be themselves aggregates of those local depressions, or cyclones, which have penetrated either into the Arctic or Antarctic regions, and have there, either partially or wholly, coalesced. Local depressions starting from the edges of the great areas of excessive evaporation seem to be governed in their course by the distribution of relative humidity, and to be determined towards those districts in which precipitation is most in excess of evaporation. Consequently their forward development is, as a general rule—a rule to which there are in the northern hemisphere many important exceptions—somewhat towards the poles. As they advance between converging longitudes they commonly expand, and therefore become united, while the influence of the earth's rotation deflects their circulating currents further away from the points of lowest pressure. Mr. Murphy's view that the imperfection of the Arctic as compared with the Antarctic depression, is due to the amount of land in the northern hemisphere, and the local air-currents produced thereby, is not in opposition to my argument. Undoubtedly over Greenland the anticyclonic circulations predominate (except in the summer quarter) over the cyclonic. It is not improbable that somewhat analogous irregularities of pressure dependent on the distribution of land and sea may exist in high south latitudes. But I still think that it is to the middle latitudes of the two hemispheres that we must look in order to find the chief cause of the contrast between the Antarctic and Arctic depressions, for it is in the middle latitudes that the majority of the local depressions originate. In the southern hemisphere those latitudes are almost entirely occupied by surfaces in which evaporation is excessive. In the northern they are represented to a large extent by areas of relatively slight evaporation and predominant precipitation.

The correlation of wind and pressure-distribution is of a kind which can hardly be stated at the same time briefly and correctly. But if it is necessary to be concise, it seems more natural in every case to regard the distribution of pressure as the primary cause of the wind than to say "the cause of the depression round the Pole is the centrifugal force of the west winds."

Lutterworth, January 9 W. CLEMENT LEY

Sense of Hearing, &c., in Birds and Insects

MR. ROMANES (NATURE, vol. xv., p. 177) is not quite correct in supposing that the Death's Head is the only species of *Lepidoptera* known to "stridulate." Possibly the phenomenon is far more general than is commonly believed, although only few instances of its occurrence have been observed. In the current number of the *Entomologist's Monthly Magazine*, Mr. Swinton details the method in which a sound is believed to be produced by *Vanessa io* and *V. urticæ*, viz., by friction of a nervure of the hind-wings against a "filed" nervure in the fore-wings. *Chelonia pudica*, one of the tiger-moths, has long been known to produce a sound (*cf.* Solier, *Annales Soc. Entomol. de France*, 1837). In 1864, Guenée (*Ann. Soc. Fr.*, pp. 398–401) notices that the genus *Setina* possesses a tympaniform organ on each side of the breast, analogous to that found in the *Chelonia*, and in the same volume he is followed by Laboulbène, who gives an elaborate anatomical description of the organ in *Chelonia*, with figures (pl. 10). Another tiger-moth (*Euprepia matronula*) is said to stridulate (*cf.* Czerny, *Verhand. zool.-bot. Vereins in Wien*, 1859); and the existence of the phenomenon is (at least) suspected in members of other groups of *Lepidoptera*.

Without being able to prove it, I suspect that birds obtain a knowledge of the whereabouts of worms and subterranean larvæ by sight, and not by sound. In the case of the thrush, I think the excrement rejected to the surface guides the bird to the right spot. The starling during breeding-time feeds almost exclusively on the larvæ of *Tipula*. Here, again, I think it is sight, and not sound that aids the bird. True, in this case there is no rejected excrement on the surface, but there is something that may be equally significant to the eye of the bird, viz., the withered condition of the plants of grass, &c., telling a tale of the mischief that is going on below. Furthermore, is it not possible that if the movements of the larvæ below the surface cause sufficient *sound* to be heard above the surface, the movements of the bird should act as a warning, and cause the larvæ to cease feeding? The withered plant tells its own tale; if only flagging, but yet with some amount of vitality in it, the chances are that a larva is still at work at its roots; if entirely dead, then the larva has departed for another plant.

Confessedly in the case of the curlew and allied birds, the matter becomes very difficult of explanation, owing to the depth below the surface at which the food is found. But do these marine and other worms always keep at the depth to which the bird is obliged to penetrate in order to obtain them? *Solen* is believed to remain near the surface until warned that an enemy is near, when it descends with rapidity. The worm might also be ordinarily near the surface, and the slight movement thereon caused by its endeavours to bury itself deeper might result in its destruction. I throw this out as a suggestion, because it is hard to believe that sound produced by the movements of an annelid could be transmitted through nearly a foot of sand. There is yet another difficulty. In the case of the curlew the sound would have to travel nearly a foot *above* the surface before it reached the auditory organs of the bird.

Lewisham ROBERT M'LACHLAN

THE "CHALLENGER" COLLECTIONS

THE following "Preamble" to a list of observing stations, printed for the use of the naturalists engaged in preparing the account of the voyage, contains so much likely to interest naturalists generally that we think it useful to publish it in NATURE:—

The special object of the *Challenger* Exploring Expedition was to investigate the physical and biological conditions of the great ocean basins; and with this object in view, during an absence from England of three years and a half, and at intervals as nearly uniform as circumstances would permit, throughout a course of 68,890 miles, 362 observing stations were established.

The following list of these stations has been compiled for the use of those naturalists who have consented to assist in the working out of the scientific results of the expedition, with a view to their being published in an official account of the voyage. Interesting observations were made on land as opportunity occurred during the short periods of the *Challenger's* stay in port, and during her short visits to remote islands; but these observations were necessarily desultory and incomplete, and it has been decided to omit their consideration from the present work, and to publish such as may appear of sufficient value in the transactions of learned societies. The Official Report will thus consist strictly of an account of the additions which have been made to the knowledge of the physical and biological conditions of the ocean by the expedition.

At each station the following observations were made, so far as circumstances would permit. The position of the station having been ascertained—

1. The exact depth was determined.
2. A sample of the bottom averaging from 1 oz. to 1 lb. in weight was recovered by means of the sounding instrument, which was provided with a tube and disengaging weights.
3. A sample of the bottom water was procured for physical and chemical examination.
4. The bottom temperature was determined by a registering thermometer.
5. At most stations a fair sample of the bottom fauna was procured by means of the dredge or trawl.
6. At most stations the fauna of the surface and of intermediate depths was examined by the use of the tow-net variously adjusted.
7. At most stations a series of temperature observations were made at different depths from the surface to the bottom.
8. At many stations samples of sea-water were obtained from different depths.
9. In all cases atmospheric and other meteorological conditions were carefully observed and noted.

10. The surface current was determined as far as possible.

11. At a few stations an attempt was made to ascertain the direction and rate of movement of water at different depths.

The numerical results of observations yielding such are now available in the logs, in the various reports of the Admiralty, and in the note-books and official journals of the naval and civilian scientific officers attached to the expedition.

The samples of the bottom procured by the sounding-instrument were carefully preserved in tubes or in stoppered bottles, either dry; or wet, with the addition of alcohol.

The samples of bottom and intermediate waters were determined as to their specific weight; in some samples the amount of carbonic acid, and in others the amount of chlorine, was determined; in others the contained gases were boiled out and sealed in tubes for future examination; and a large number of samples were reserved in stoppered bottles for analysis.

The mud and minerals and inorganic concretions brought up by the dredge or trawl were preserved in large quantity in boxes or jars for examination and analysis.

The collection of invertebrate animals is of great extent; and from most of the species being undescribed, and from the great peculiarity of the distribution of the fauna of the deep sea, it will perhaps yield the most generally interesting results.

The invertebrate animals from the deep-sea stations were, with few exceptions, placed in jars of rectified spirit, closed with stoppers smeared with a mixture of tallow and wax, covered over with bladder, and the tops painted with a black varnish. The animals of different groups were in many cases roughly selected at each dredging, and put into different jars; but frequently, in order to save jars and spirit, it was necessary to put the whole result of one dredging into one or two jars, the animals of all groups mixed. Each jar was marked outside with the locality and the number of the station; and the station number, written with a black pencil on a slip of parchment, was placed *within* each jar. The collection on its arrival in this country was thus arranged geographically. It came home in most excellent order.

To insure accuracy so far as possible, the observing stations have been numbered from 1 to 354, and a number corresponding to the station is on every sample of every description, and on every record of the result of observations for every station; and the same number is carried through the whole series of journals and other books kept by the members of the Civilian Scientific Staff.

It is now our object, in preparing a scientific account of the voyage, to describe these investigations, and to give their results in detail; and to develop, as far as possible, the bearings of these results upon one another, and upon the broad problems of physical geography and hydrography.

For this purpose it is necessary that the various numerical results should be reduced and tabulated; that the samples of soundings should be examined chemically and microscopically; that the samples of water and of air should be analysed; and that the animals procured by the dredge should be most carefully catalogued as to localities, and the forms new to science described.

The data for the physical and chemical work are in few hands, and these chiefly at head-quarters. It is especially for the assistance of the naturalists dealing with the deep-sea fauna that these notes are drawn up.

Prof. Agassiz, Mr. Murray, and I have now gone over the whole of the collection of marine invertebrate animals in spirit; and we have separated the zoological groups from one another for each station, and re-arranged the collection in zoological order. Each jar, therefore, now contains animals of one group only (*e.g. Ophiurids* or *Alcyonarians*), to be described by one person. Each jar has within it a station number, which refers to the specimens which are loose in the jar; but in many cases, to save space, and to lessen the number of large jars, there are in the same jar several packets done up in muslin, each packet containing animals of the same zoological group from another station, and each packet having within it its own station number.

The jars will be placed in the hands of the naturalists who undertake the description of the different groups in their present condition; and in order to secure uniformity and the safety of the collection, they are requested—

1. To go carefully over the whole collection intrusted to them, and to select a first series, including all unique specimens and a sufficient number of specimens of those of which there are several duplicates, to illustrate their geographical distribution; and to associate with each species a particular number, by which number that species may be always referred to afterwards—at all events, until it has been described and named. This is the collection which is to be described and figured, and it is ultimately to be placed as a collection of types in the British Museum. It will usually be desirable, for the purposes of description and illustration, to put the specimens of the first series into rectified spirit in clear glass bottles; and I will arrange in each case how the bottles are to be provided and the expense defrayed. This collection must be retained by the describer until the description of the whole is finished.

2. To select at the same time a second set, consisting of a complete series of duplicates, numbered to correspond with the numbers attached to the first series species for species, and to pack them either in separate bottles or in packets in muslin, a number of packets together in one store bottle. This set to be returned to me for reference.

3. To pack up again all the duplicates from the different stations, each species from each locality either in a separate bottle or in a muslin packet, with the station number and the number corresponding with the type specimen of the species along with it. It will greatly facilitate matters if this general duplicate collection is returned to me along with the first series of duplicates, whenever the collection has been gone over, and the first series for description selected out.

4. For easy reference, each naturalist who undertakes the working out of a group will be provided with a large number of small vellum labels, marked thus:—

Ast.	(Asteridea.)
St	(Station.)

and he need simply enter, *with a dark pencil*, the number which he has associated with the particular species, and the number of the station where the specimens were found; and put the label *into* the bottle or the muslin bag, as the case may be.

Special arrangements must be made in every individual case as to publication, but it is the general intention that the account of the voyage shall be in a series of volumes quarto, of the size of the *Philosophical Transactions* of the Royal Society. It will probably consist of—

1. Two volumes, containing—(1) such a general account of the voyage, and such hydrographic details, illustrated by charts and sections, as may be necessary for the clear comprehension of the scientific observations; and (2) a full discussion of the general results of the voyage, physical and biological. To these volumes will be appended tables of the routine observations in meteorology, &c., made during the voyage.

2. A volume containing an account of the physical and chemical observations and investigations, with a special discussion thereon. To this volume will be appended tables of analysis, tables of specific gravities, reports on the microscopical examination of minerals, &c.

3. A series of volumes, probably not less than six in number, containing a detailed account of the fauna, and plates illustrating the undescribed or imperfectly known forms.

In case of plates being required, the space available for figures on each plate is not more than 11 by $8\frac{1}{2}$ inches (= 28 by 12·5 centimetres). It is intended that the plates shall be, generally speaking, in lithograph; but if any form of engraving seem preferable in any case, a special arrangement may be made. Woodcuts will be given where required.

I undertake the editing of the work, and all manuscripts and proofs of plates are to be sent to me.

All packages and letters to be addressed—

Professor Sir Wyville Thomson, F.R.S.,
University,
Edinburgh.

and marked "*Challenger.*"

The intention at present is that the preparation of all the volumes shall go on simultaneously, and it is earnestly desired that the different parts may be done as speedily as is consistent with the utmost care and accuracy. Authors are invited to enter into any anatomical or other details which may be desirable for the full illustration of the groups in their hands; and their full consideration is particularly requested of all questions bearing upon geographical distribution, and upon the relation of the deep-sea fauna to the faunæ of the later geological periods.

Authors will be at full liberty to publish abstracts of the results of their work during its progress, in the proceedings of Scientific Societies; but such communications should be made through me or with my knowledge, and "by permission of the Lords Commissioners of the Treasury."

I am directed to report to Government and to furnish my accounts at certain intervals; and in order that I may be able to do so, authors are requested to report progress and to render accounts and vouchers for any expenses which they may have incurred, to me quarterly; on or before the 1st of March, of June, of September, and of December.

In the following list of stations—

1. The number is given by which each particular station is referred to throughout. The first eight stations, to which Roman numerals are attached, are to be considered in a certain sense preliminary; the regular series commences with Station 1 (*bis*) on the 15th of February, 1873, and is indicated by Arabic numbers up to 354.

2. The date is given.

3. The exact position of the ship at noon of the day on which the observations were made.

4. The depth in fathoms (= 6 English feet).

5. An abbreviation, as it is given on the chart, indicating the nature of the bottom:—

r. (rock) indicates hard ground, where nothing was brought up by the sounding instrument, there being at the same time evidence that the tube had reached the bottom.

m. (mud), a material varying in colour, but derived chiefly from the disintegration of the land.

gl. oz. (globigerina ooze), a white or greyish deposit formed in a great measure of the shells, entire or broken, of foraminifera belonging to the genera *Globigerina, Orbulina, Pulvinulina,* and *Hastigerina,* usually with a quantity of amorphous calcareous or earthy matter, and many coccoliths.

di. oz. (diatom ooze) indicates a deposit formed to a great extent of the frustules of diatoms which have sunk from the surface.

rad. oz. (radiolarian ooze) indicates a deposit composed mainly of the skeletons of Polycystina and other Radiolarians.

r. cl. (red clay) indicates a deposit, very widely extended in deep water, of red, reddish, or grey aluminous mud, such as would be produced by the decomposition of a felspathic mineral. This deposit varies considerably in character; it seems to be derived from several sources, but one of the most important of these appears to be the decomposition of pumice and other volcanic products. The "red clay" often contains concretionary nodules, consisting chiefly of the oxides of manganese and iron.

gr. oz. (grey ooze), and gr. m. (grey mud), usually indicate an intermediate condition between Globigerina ooze and red clay, or in some cases a fine-grained grey deposit, formed in deep water, chiefly of land *débris.*

The positions of the stations are shown on the accompanying chart. C. WYVILLE THOMSON

Edinburgh, January 2

PROF. AGASSIZ ON THE "CHALLENGER" COLLECTIONS

PROF. AGASSIZ, who has come to this country for the express purpose of examining the *Challenger* Collection, has kindly sent us the following notes on what he has already seen:—

I have seen a great many alcoholic collections of marine animals made by direction of different government expeditions, and in no case have I seen one in a better state of preservation, or where greater care had been taken to insure the accuracy of the locality. Those who work up the material will have the double advantage of working on admirably-preserved collections, and of being absolutely certain of the exact locality of their specimens. Sir Wyville Thomson has already called attention, in his Preliminary Reports to the Royal Society and his Lecture before the British Association at Glasgow, to many of the most interesting things collected, and he has also alluded to the amount of the material brought together. I may perhaps give a better idea of the magnitude of the collections by stating that if a single individual, having the knowledge of the eighteen or twenty specialists into whose hands the collections are to be placed, were to work them up, he would most certainly require from seventy to seventy-five years of hard work to bring out the results which the careful study of the different departments ought to yield.

We may assume that the work of the *Challenger* has probably accomplished for the depths of the ocean in general what the American and English expeditions of 1866–1869 did for the North Atlantic, for it certainly is remarkable how much these expeditions, working over a comparatively limited area, contributed to the knowledge of the deep-sea fauna, and how little of novelty has been added by the subsequent and more extended work of the *Challenger* over the same ground. Judging from these premises, we may fairly say that hereafter, while any new expedition will undoubtedly clear up many of the points left doubtful by the *Challenger,* and may carry out special lines of investigation only partly sketched out, yet we can hardly expect them to do more than fill out the grand outlines laid down by the great English expedition.

To attain the best possible results it is of the utmost importance that the collections brought home should be placed in the hands of specialists who are thorough masters of their respective departments. The scientific public will therefore hear with the greatest satisfaction that the Government has left the collections in the hands of Sir Wyville Thomson, who is to direct the publications until the whole of this invaluable material is thoroughly worked out.

REMARKS ON THE NEW MONOTREME FROM NEW GUINEA

A FEW weeks ago we announced to our readers the remarkable news of the existence of a mammal of the order Monotremata in New Guinea. The receipt of a separate copy of the description of this animal, just published by Dr. W. Peters and the Marquis G. Doria,[1] enable us to give a few more particulars of what must be universally regarded as one of the most important zoological discoveries of the period.

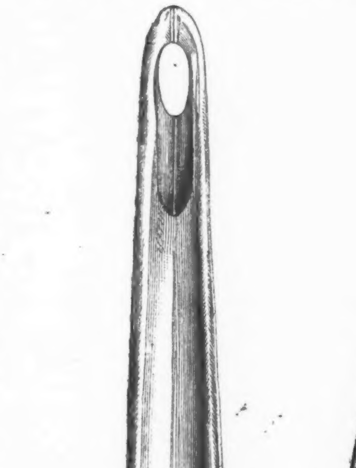
Mr. Bruijn, of Ternate, to whom science is indebted for our first acquaintance with this novelty, gives the following details of its discovery in a letter to the Italian naturalist, Dr. Beccari :—

"Two years running my native collectors have brought me word that, according to the Papuan mountaineers, there are a good many mammals in New Guinea, but that they are only hunted there when they are required for food. At first I did not place much confidence in these stories, because I know the little value of the reports of the hunters and the natives in general. Nevertheless, I have always told them to look carefully for mammals. The last time they set out I told them, in order to stimulate their zeal, that I knew that a certain animal existed in New Guinea of which I showed them a figure, and that I wished to have it at any price, hoping that in searching for it they would, perhaps, find other new or little-known species. The figure which I showed to Joseph and the other hunters was that of an *Echidna.*

"This year (1876) my men ascended a peak of the Arfaks called Mickirbo, and halted at a spot about the same height above the sea-level as Pjobieda. Here Saleh entered a hut where a piece of a skull of a mammal was offered to him, which he at once thought belonged to the animal which I required. He accepted it and forthwith commenced interrogating the Papuan who had given it to him. The latter told him that the skull belonged to an animal with four legs, with a tail, as large as a dog, and with long harsh fur ; he added that these animals were not uncommon on Mount Arfak, and concealed themselves in small caves, and that the Papuans hunted them with dogs, being very fond of their flesh. The skull in question belonged to an animal that had been killed about a month before. Acting upon this information, Saleh set to work to hunt for this animal, but without success. It was only after he had descended from the mountains that a second skull was brought to him, which was still stinking from the fragments of rotten muscles attached to it."

One of these two crania reached the Museo Civico of Genoa, in November last, and constitutes the material upon which Messrs. Peters and Doria, who are engaged on a joint memoir upon the Mammals and Reptiles of New Guinea, have founded their *Tachyglossus*[2] *bruijnii.*

It will be observed that this skull, of which a figure is given herewith (Fig. 1), copied from that of Messrs. Peters and Doria, wants the greater part of its posterior portion, and also the lower jaw. But it is quite perfect enough to enable one to see at a glance that the species must be quite distinct from the Australian *Tachyglossus hystrix* and *T. setosus.* In the first place the size of the skull is much greater, and the rostrum of the new species is longer by one half, measuring in total length about 6·4 inches, instead of 4·2 inches, as in the Australian animal,[1] of which a skull is represented (Fig. 2) for comparison. Again, in the Papuan species, the rostrum is curved downwards throughout its length, which is not the case in the Australian forms. Other minor differences are pointed out by Messrs. Peters and Doria in their excellent description, which we need not repeat here. It is quite sufficient to compare the outlines of the two skulls together to convince oneself that the newly-discovered



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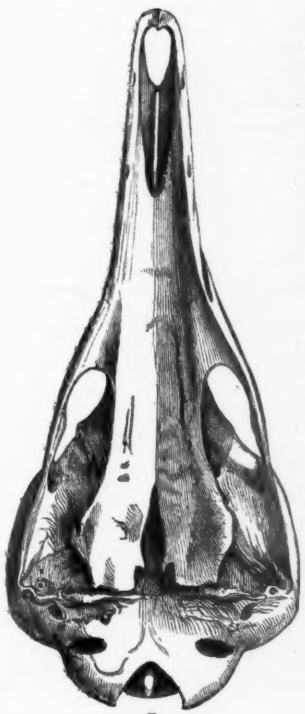

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FIG. 1.—Skull of Tachyglossus of New Guinea. FIG. 2.—Skull of Tachyglossus of Australia

[1] W. Peters e G. Doria : "Descrizione di una nuova specie di Tachyglossus proveniente dalla Nuova Guinea settentrionale." Ann. Mus. Civ. di St. Nat. di Genova, vol ix. (December 3, 1876)

[2] The "Spiny Ant-eater" of Australia is usually called *Echiana* in scientific nomenclature, but Messrs Peters and Doria reject this term in favour of *Tachyglossus* of Illiger, because *Echidna* was previously applied by Foster in 1778 to a genus of fishes.

[1] It is not known to which of the two Australian species this skull belongs, but they are closely allied, and as regards size there is little if any difference between them.

animal must belong to a much larger and quite distinct species, of which we trust it will not be long before perfect examples are received in Europe.

The significance of the discovery of a species of *Tachyglossus* in New Guinea will be appreciated when we consider that hitherto the Monotremes or Ornithodelphs, which, according to the most recent authorities, constitute not merely a distinct order, but even a separate sub-class of mammals, have been supposed to be at present exclusively restricted to Australia. The two only known genera of Monotremes are *Tachyglossus* (sive *Echidna*) and *Ornithorhynchus*. Of the latter the single known species is peculiar to South-Eastern Australia, of the former, the two species are found, one in South-Eastern Australia, and the other in Tasmania. The whole of the north and west of the Australian continent is, so far as we are at present informed, without any representative of this remarkable group. Looking at these facts, the discovery of a species of Monotreme in New Guinea becomes still more significant, and leads us to expect that when the mountain-ranges of Queensland have been further explored, some representative of the order may still be found lingering in this district, and uniting the newly-discovered area of distribution with that previously known.

Finally we may remark that the fundamental unity of the Papuan and Australian fauna was already sufficiently obvious by the existence amongst mammals of *Macropus* and amongst birds of such peculiar genera as *Orthonyx* and *Climacteris* in New Guinea. The discovery of *Tachyglossus bruijnii* is another confirmation of the correctness of this view, as regards zoology, though, as regards the flora of New Guinea, facts, we believe, point rather in another direction. P. L. S.

ON THE TROPICAL FORESTS OF HAMPSHIRE[1]

II.

IT has been mentioned that in some of the clays remains of leaves, fruits, and flowers are met with, and I will now proceed to tell you something about them. There are some enlarged drawings here on the wall which I should tell you are not all enlarged to equal scale, and there are trays of specimens on the table.

These leaves are found in various conditions of preservation. In most cases the impression only of the leaves in the clay is met with, but in some cases they are so well preserved that the actual substance has been retained although chemical changes have altered its composition, and it will peel off and blow away. In some of the clays the masses of leaves are so decayed that they cannot be recognised, and are not worth our collecting.

Where the preservation is good we can readily distinguish the various original textures of the leaves by comparing their general aspect and colour both among themselves and with existing forms. For instance, those which are thick, such as evergreens, thin, as convolvulus, hard, such as oak, or soft, such as lilac, or even velvety, such as the common phlox, can all be recognised. Their colours, in most of the beds, vary from buff to brown, but I need hardly tell you that in no case have we any of the green colouring of the leaves preserved. Whilst these various shades of dark buffs and browns are in many cases the result of chemical change that has taken place after the leaf was covered up, yet I believe that in many cases this change had occurred, at least partially, before the covering up, just as we saw a few weeks ago the changed colours of the fallen leaves of autumn.

In the darker clays the remains are black and completely carbonised; where this is so the finer venation is indistinct and the remains difficult to save, so that we may discard them unless the outline of the leaf is of unusual form. The darker browns, I take it, indicate hard and evergreen leaves; for instance, the laurel-like leaves are always of a deep colour, whilst both the thin and the succulent leaves are always of light colour, as in the leaves which we suppose to be fig, some species of smilax, &c.

No other colours have been met with with one remarkable exception; fragments of a reed-like aspect are found of a deep violet, staining the surrounding clay mauve for a considerable distance.

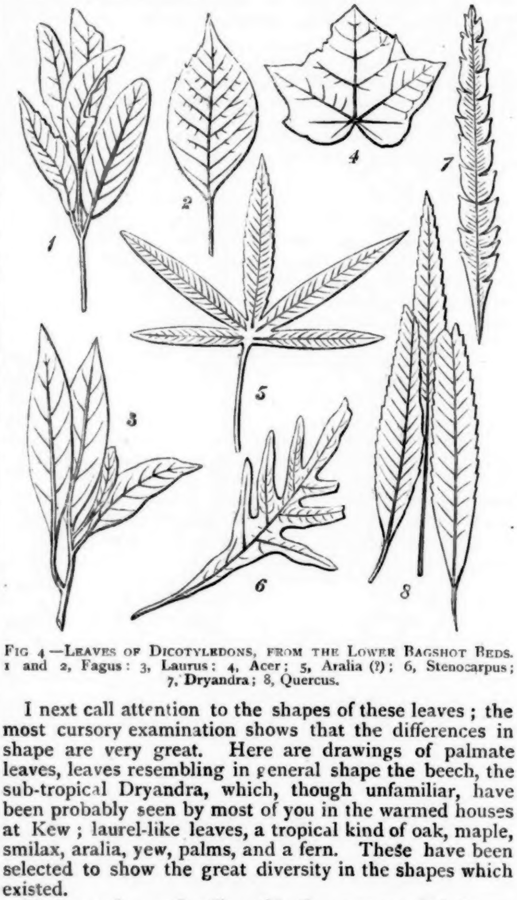


FIG 4.—LEAVES OF DICOTYLEDONS, FROM THE LOWER BAGSHOT BEDS. 1 and 2, Fagus: 3, Laurus: 4, Acer; 5, Aralia (?); 6, Stenocarpus; 7, Dryandra; 8, Quercus.

I next call attention to the shapes of these leaves; the most cursory examination shows that the differences in shape are very great. Here are drawings of palmate leaves, leaves resembling in general shape the beech, the sub-tropical Dryandra, which, though unfamiliar, have been probably seen by most of you in the warmed houses at Kew; laurel-like leaves, a tropical kind of oak, maple, smilax, aralia, yew, palms, and a fern. These have been selected to show the great diversity in the shapes which existed.

Most people are familiar with the process of skeletonising leaves—that is, the removal of the green part, and the preservation of what is called the skeleton. I have here a large case of leaves so prepared by Mrs. J. E. Gardner, and which may be examined at the close of the lecture.

I would next draw attention to some leaves of trees which are well known as now growing in England. In these a continuation of the leaf-stalk can clearly be distinguished running through the leaf, which is commonly called the *mid-rib*. [The mid-ribs in two diagrams were coloured red.] Those running from the primary ribs are called *secondary* ribs (coloured blue). There are, again, running from these many smaller portions, which are called the network of the skeleton. In some, as, for example, the plane-tree, there are three primary ribs; in a few leaves

[1] Lecture in connection with the Loan Collection of Scientific Apparatus, given at the South Kensington Museum, December 2, 1876, by J. Starkie Gardner, F.G.S. Continued from p. 233.

there are more. In some, these principal ribs are very strong, and form prominent features; in others, as in the convolvulus, they are but slight. Some of these secondary ribs run straight to the margin, and in other cases they are curved. Again, in some they run right out to the extremity of the margin, as in the elm; and in others they are curved back, as in the fig. These are things to be noticed, which it will be seen are of consequence.

I wish now to refer to the character of the margins of the leaves. Here is a drawing of a fig leaf in which a perfectly smooth margin will be observed; whilst the elm is saw-like, or *serrated*, as botanists call it. In the dryandra the margin is deeply notched, whilst in a strange-looking form (Stenocarpus) the edge is markedly lobed; in the case of some palmate leaves the edge is smooth, as in the passion-flower, or serrated, as in the fossil aralia. Those who have paid any attention to leaf form, have no doubt observed that leaves, even from the same plant, differ in some of these characters. This constitutes one of the greatest difficulties which presents itself to the botanist, in the endeavour to decide by comparisons to what plants the fossil remains probably belonged. Still, there are numbers of specimens with which we have to deal presenting forms so unmistakably alike that we are able to group them together; and even putting on one side many fossil forms about which we must feel considerable hesitation, there still remain a vast number about which we can feel little hesitation as to the value of the comparisons.

It is worth while to point out that when we compare these leaves with the existing flora and contrast in like manner the plants of the coal period with the existing vegetation, we see that there is a much closer resemblance between these plants and the present plants than there is in the case of coal plants. That is, that in these forms we have a nearer approach to the existing state of things than there was in the coal period, a matter which, in viewing the evolution of plant life, cannot be overlooked, whatever may be the value to be set on such evidence. Those who know anything of the plants of the coal period are aware that we find there gigantic forms of which we have only dwarf representatives at the present time. The principal of these forms are gigantic horsetails or Equisitaceæ, great lycopods, as the Lepidodendron and Sigillaria, and tree-ferns, all very unlike the representatives of these groups now living. Here, however, the resemblances to the existing vegetation is close, not only in the arrangement of the ribs, but the size of the leaves, and also in those cases where we have groups of leaves joined by twigs, the method of attachment is similar.

To determine to what kind of plants each of these leaves belongs is a matter of considerable difficulty and requires an extensive knowledge of the plants now living on the earth. Although we have collections of growing plants from different parts of the world in various conservatories, such as at Kew, it is on the dried specimens brought home by travellers, or sent from abroad, that we mainly have to depend. How frequently leaves closely resembling each other but belonging to plants of widely different kinds are met with, the careful student of botany knows well. It requires a comparison by a skilled eye of the most minute details to arrive at conclusions on which any reliance may be placed.

The work of comparison of this immense number of leaves is necessarily a work of considerable time, and is still in progress, but some conclusions have already been arrived at. I call your attention to a large group of growing plants, from the conservatory of Mrs. J. E. Gardner, which illustrate the kind of foliage existing in England in the Eocene time. Those who have paid attention to this subject will not doubt that these are palms; these are unmistakable ferns; botanists are agreed that this form is undoubtedly referable to the group to which *this* dryandra belongs; this may with almost certainty be referred to the beech tribe; this doubtless belongs to the same tribe as the pea; this is an aralia; this an acer or maple; this a laurel, and this a yew. Specimens of elm, acacia, chestnut, great aroids, as well as hundreds of other forms, have been obtained, some of the comparisons of which have already been determined, and some few are of forms which appear to have no living analogies whatever. There are also countless fruits, many of which can be recognised as like those now existing; a few flowers too have been met with. These fruits are of great assistance in telling us what plants were living at the time, as they are compared with greater certainty than the leaves can be.

I have mentioned the cabinets in the Loan Collection; close by is a cabinet which contains the collection made by Baron von Ettingshausen, and although time does not permit me to do more than allude to them, I would just mention that collections of an approximately similar geological age have been made from Switzerland, Italy, Greenland, and Austria, so that taking together all these localities we get a fair notion of what was the vegetation of the period which geologists call Eocene. You must remember geology is a study only of this century. Interest, at first small, spreads now over all Europe, and gradually records of past vegetations of different ages are being brought to light and compared.

I would say a word or two by way of explanation of the origin of the different colours of the sands and clays which have been mentioned. The yellows, buffs, and reds, which form the prevailing colours of the lower series, owe their origin to iron in various chemical conditions. The granite from which they were derived contains sufficient iron to account for iron being in solution in the streams by which they were deposited. The different colours of the different oxides of iron are here shown. The anhydrous sesquioxide is of a deep tinge: the hydrous sesquioxide gives a yellow colour. [A successful experiment was then made with a large glass jar of rain-water with dissolved grey granite held in suspension. To show the amount of iron present in the granite, a little ammonia was added, which changed it to a dark colour. The green oxide thus obtained would, on evaporation of the water, take another degree of oxygen and change to a bright red sesquioxide. This red oxide was produced in a second jar, and shown to be the same as the colouring matter of the red clays.] De la Beche, in his researches in theoretical geology, alludes to the fact that pipe-clays of similar colours are now being deposited in some of the lakes of North America.

Whilst some of the dark colouring of the darker clays is due to iron, that of some of the middle clays may be due to the fact that, whilst these beds were being deposited, the source of the stream was coming from a district farther north, cutting perhaps across the Somersetshire and Gloucestershire coal-field.

The question may perhaps have presented itself to your minds—how is it possible that the tropical forms of which we have spoken, such as the *palm*, *aroids*, *cactus*, &c., could have grown alongside of the apparently temperate forms, such as the *oak*, *elm*, *beech*, and others. Time does not allow that I should go at any length into the explanation of this; but I may just remind you that in the long geological record of the beds found in England, there are to the geologist unmistakable indications of many changes in climate. Further, astronomers, having calculated the path of the revolution of the earth in ages past, tell us that in successive periods, each consisting of about 26,000 years, each hemisphere, northern and southern, has been successively subject to repeated cyclical changes in temperature. There have been for the area which is now England many alternations of long periods of heat and cold. Whenever the area became warmer, the descendants of semi-tropical forms would gradually

creep further and further north, whilst the descendants of cold-loving plants would retreat from the advancing temperature. *Vice versâ*, whenever the area became gradually colder, the heat-loving plants would, from one generation to another, retreat further and further south, whilst the cold-loving plants would return to the area from which their ancestors had been driven out. In each case there would be some lingering remnants of the retreating vegetation (though perhaps existing with diminished vigour), growing alongside of the earliest arrivals of the incoming vegetation. Such is a possible explanation of our finding these plant remains comingled together. It must, too, be borne in mind that it is not so much the mean temperature of a whole year which affects the possibility of plants growing in any locality, as the fact of what are the extremes of summer and winter temperature. For example, one place may have a mean winter temperature of 50°, and a summer one of 70°; while another place might have a mean winter temperature of 20°, and a summer one of 100°, and yet both have a mean *annual* temperature of 60°. In Cornwall the maiden-hair fern grows in sheltered localities, because the winter temperature never sinks to the point that would cause its destruction. Again, at that most charming spot in the west of Ireland, Glengariff, the arbutus still forms an abundant underwood; and the Irish filmy fern flourished in many favoured spots until quite recently, when the modern, too comfortable Eccles Hotel has retained tourists in the district, who have ruthlessly carried off, as reminiscences of a pleasant holiday, this which was one of the most attractive features to the botanists.

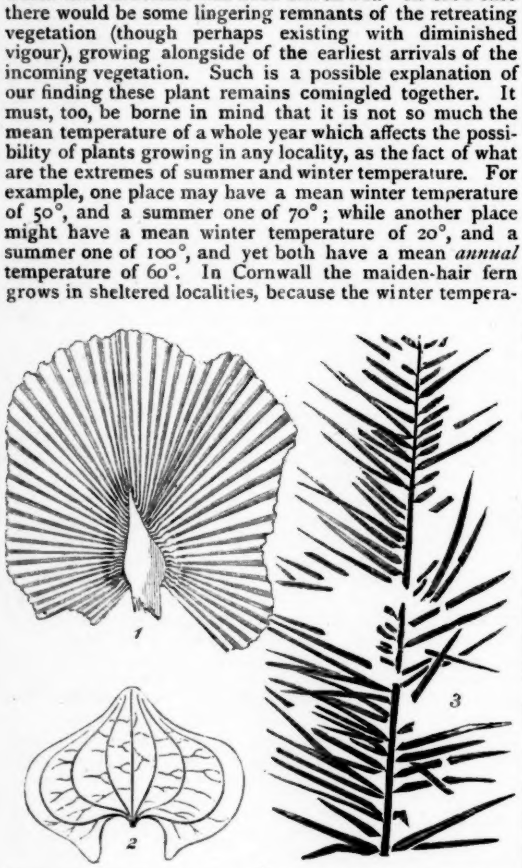


FIG. 5.—GROUP OF MONOCOTYLEDONS, FROM THE LOWER BAGSHOT BEDS. 1, Fan Palm; 2, Smilax; 3, Feather Palm

These facts, which seem so simple when laid out in diagrams, are the results of long-continued and careful work; but you may take my word for it, having enjoyed the pleasure during my holidays for many summers, that hunting for fossils is a fine, healthy and active exercise. As regards this particular district, let me tell you some of my experiences. Fossils are not to be obtained here without hard work; the steep and crumbling cliffs have to be climbed, and most diligent search has to be made for indications of them. Fifty times, perhaps, the cliff may be laboriously scaled to examine what appears from the beach to be a promising-looking patch of clay, to result only in disappointment; either the clay turns out to be too sandy, and the impressions valueless; or it contains nothing; or it is found, on nearing it, to be inaccessible. But supposing well-preserved leaf-impressions reward the search, a secure footing has first to be cut with a light pickaxe; then the sands or clays overlying the leaf-bed have to be removed by spade and pick—real navvy's work this—then to get out blocks large enough to contain the palm-leaf shown in this drawing, which is only enlarged twice, the leaf-bed has to be undermined to a depth of five or six feet, a difficult operation requiring patience, and the then hanging mass of clay has to be cut off with the pick, being too plastic to break away by its own weight. When nearly cut through, it gradually breaks away, and falls gently on to the platform prepared for it underneath. The blocks thus obtained are sometimes too large for three or four men to tilt over. The method is then to leave them to dry, as when wet the clay will not split to disclose the leaves. It is then, I can assure you, that I esteem myself fortunate if some too curious excursionist, or enthusiastic townsman, does not arrive during my absence with a hammer to break the blocks up. So great has been the curiosity excited, that fossilizers have so far forgotten their sense of justice as to get up at daybreak to appropriate the result of my work had not the faithful coast-guardsmen, with a keener sense of justice, been near.

Wet weather of course puts a stop to operations, and buries the working in mud and sand, sometimes two or three feet deep even in a single night. When the workings are as far off from your headquarters as at Poole Harbour, and the specimens heavy, a boat is necessary to convey them home. The most enjoyable moments are, perhaps, those occupied in splitting the blocks, as one then shares what I should suppose to be the excitement of gold-workers, except that gold-finding must be more monotonous, as in this case no one can say what sort of treasure may reward us next. Anyhow, it is a recreation strongly to be recommended to those who like healthy exercise, freedom, and the sea.

[A large and heavy block of matrix was then split, in illustration of this part of the lecture, and a layer showing hundreds of leaves, exposed for the first time to view.]

I have now endeavoured to give you as accurately as I can, the absolute facts as far as we can learn them, respecting the conditions under which these beds were deposited, the sources from which the material was derived, and so far as we can tell, by comparison with existing vegetation, what were the trees of which these leaves are the records, and also the climatal conditions under which they grew. We may now, in conclusion, allow our imagination to come into play, a scientific use of the imagination, I hope it is, while we picture to ourselves the appearance of this area during the time these beds were being formed. The changing force of the streams and their directions varying from time to time, would, as we have already said, frequently undo the work of accumulation which had been previously done.

We have reason to believe that there was here a width of valley closed in to the north by the chalk hills which are still represented by the chalk range of North Hampshire and Wiltshire, and on the south and east by accumulations forming the lagoon barrier of which I have spoken. The course of the stream was from west to east. To the east was the sea, to the west was the valley of the stream, about some of the conditions of which we are necessarily uncertain, in consequence of the changes from upheaval and denudation, which have extensively modified that district. When the streams were from the rainy seasons swollen they moved along at a rapid rate, sweeping away previously deposited beds and also bringing down coarse quartz grit and blocks, which formed the gritty beds of which I have spoken. When the streams were not so violent then there were doubtless frequently

repeated scenes such as I will now attempt to describe to you. In this ideal picture I have endeavoured to depict what I consider to have been the state of things. Here we have the valley of the river some six or seven miles broad. The streams reduced to streamlets meandering through dried and barren sand-banks. Among them are more elevated patches—islands, if we may use the term—islands standing up from the general expanse of sand, and in some cases actual islands in the sense that they were surrounded by water. Here and there pools of water, some almost stagnant, others fed by minute streamlets.

Looking at the scene from a southern standpoint we should see to the north the distant chalk range. Whilst along the shore of the opposite bank of the valley we could with some difficulty detect the various forms of vegetation, which we should see with greater clearness in the more immediate foreground. In this valley a singular stillness must have prevailed, as no trace of animal life whatever has been found, except a feather and a few insect wings blown in from the southern bank.

Of the following at least we are pretty sure, and of numerous others we can be almost sure, but there are indications of very many besides, the relationships of which are at present but imperfectly defined.

Here we should see the graceful fan-palm and the feather palms, adding softness to the view by their elegantly-curved and drooping leaves, laurel and dwarfed oak, stately beeches, clumps of feathery acacia, trellised and festooned with smilax, the trailing aroid, with its large and glossy foliage and an undergrowth of *Mimosa* and of cypress in the swampier ground, and variations in colour caused by the foliage of cinnamon and fig, and the ground clothed with ferns and sedges. On the barren sands of the distant valley are growing clumps of giant and weird-looking cactus. It is not difficult to picture to ourselves the view. (See Fig. 2.)

All this beauty is gone. We have nothing but these records of what must have been a view of great loveliness, which only the toil of the geologist can even faintly reproduce.

"The hills are shadows, and they flow
From form to form, and nothing stands;
They melt like mist, the solid lands,
Like clouds they shape themselves and go.

"There rolls the deep where grew the tree.
O Earth, what changes hast thou seen!
There where the long street roars, hath been
The stillness of the central sea."

THE REPORT ON THE AUSTRIAN "NOVARA" EXPEDITION

A FEW days ago Admiral v. Wüllerstorff Urbair, late Commander-in-Chief of the Austrian *Novara* Exploring Expedition, had an audience of the Emperor to present to his Majesty the final report on the scientific results of this great exploring cruise round the world. It has required about seventeen years' serious labour, and has cost nearly 13,000*l.* sterling to complete this important scientific work, embracing 18 vols. 4to. and 3 vols. 8vo., and containing the anthropological, botanical, geological, zoological, physico-nautical, statistico-commercial, medical, and descriptive parts.

The narrative of the expedition, written by Dr. Karl von Scherzer (an author also well known in England, and at present attached to the Austro-Hungarian Embassy in London), has met with such a success that five editions have been published and more than 29,000 copies sold.

The most interesting of the purely scientific publications is the geological part, by Dr. Hochstetter, which gives the most complete description of the geology of New Zealand, the author having been the first naturalist who thoroughly explored these antipodean islands, and he has carefully examined and described its gold and coal deposits. The statistico-commercial part, by Dr. Karl von Scherzer, has become quite a standard book on the Continent.

The price of the complete series being very high (391 florins, or nearly 40*l.* sterling), the Emperor has given permission that a considerable number of copies of this most valuable publication should be given away to public institutions and libraries in the empire, as well as in foreign countries, and as the *Novara* has met with a particularly kind reception in the British colonies, the libraries of these have been considered first in the list of recipients of this great national work, which is a monument of scientific investigation.

THE CYCLONE WAVE IN BENGAL

AN interesting correspondence on this subject has appeared in the *Times* during the last few days, evincing generally on the part of the correspondents an earnest effort to arouse the public mind to a sense of the necessity of something being done towards mitigating the calamitous results of such occurrences in the future. The subject being one that must sooner or later be faced, it is beside the question to point to the destructive flooding of the Thames as a proof that the Government of India does not differ greatly in such matters from similar authorities at home.

As regards the meteorology of this important question, three lines of inquiry stand prominently out as calling for special and extended investigation. The first of these is a thorough discussion of the storms of the Bay of Bengal, or a continuation of the work under this head which has been ably begun by Mr. Blanford and Mr. Willson. The second line of inquiry is the cause or causes which originate the cyclone wave and determine the course it takes—a subject on which we cannot be said to have any information at present, all that is or can be said being little more than unsatisfactory conjectures. To carry out these inquiries with the fulness and with the detail required to ensure a successful handling of the subject additional stations must be established and the taking of meteorological observations must be more extensively and frequently done than is now the practice on board the ships which navigate the Bay.

The third line of inquiry is the systematic inauguration of a meteorological survey of the Bay of Bengal and its shores, with a more strict reference to its storms, by having first-class meteorological stations established at Trincomalee, Madras, Vizagapatam, False Point, Saugor Island, Chittagong, Akyab, Cape Negrais, the Andaman and the Nicobar Islands, these stations having a full equipment of instruments, including in each case a continuously registering barometer and anemometer. With these instruments the law of the diurnal oscillation of the barometer and of the changes in the direction and velocity of the wind, including the variations with season, would become known, and any deviation therefrom which may happen to occur, could be telegraphed at once to the head office at Calcutta. It may be regarded as absolutely certain, that no long time would elapse before the nature of the disturbing force, cyclonic or otherwise, revealed by the anomalous readings of the barometer and anemometer would come to be correctly interpreted; and with the aid of frequent telegrams from the whole circuit of stations, so well interpreted that the superintendent at Calcutta would have no difficulty in localising the cyclone, its track and rate of progress would be so certainly known that warning could be sent to the coasts threatened by it.

This system of storm warnings must not be confounded with that practised in Great Britain, in which no refined system of observations is called into play, and in which no accurate knowledge of mean periodic changes is required. What is chiefly required in this country is a

vigilant outlook for what may be called the grosser changes of atmospheric pressure and of the wind, and a very moderate knowledge of meteorology for their interpretation. So clearly is this the case that notwithstanding the great advances made by meteorology in recent years no progress has been made in this country in issuing warnings of the approach of storms, since the number of fresh gales (8 of Beaufort-scale) of which warnings have been sent are still somewhat under the percentage of success attained by Fitzroy in 1864.

But in India it is different. Any system of storm-warnings there, to be successful, must be based on a refined system of observation carried on at a considerable number of stations in such positions as we have pointed out—those positions being selected with special reference to this inquiry.

OUR ASTRONOMICAL COLUMN

AN OBSERVATORY ON ETNA.—Prof. Tacchini sends us a note read before the Accademia Gioenia on September 22, 1876, entitled, "Della convenienza ed utilità di erigere sull' Etna una Stazione Astronomico-Meteorologica," in which after describing his experiences during a brief ascent on September 15-16, he expresses his views with regard to the establishment and most desirable fitting of an observatory on the mountain to be mainly devoted to spectroscopic and meteorological observations.

Prof. Tacchini ascended on the morning of September 15 from Catania to the station occupied by a party of the English and American expeditions on the occasion of the total solar eclipse of December, 1870, and found there a diminution of temperature of 33° Centigrade. He had taken with him a Dollond-telescope of $3\frac{3}{4}$ inches aperture, a spectroscope of strong dispersion by Tauber, a small spectroscope of Jannsen, an aneroid barometer, thermometers, and a polariscope. At 10h. 30m. A.M., on the 16th, a few detached clouds only being present, he remarked that the blue of the sky was much deeper than at Palermo or Catania. The solar light had a special character, it seemed whiter and more tranquil, as though due to artificial illumination by magnesium. Viewing the sun rapidly with the naked eye, it was seen as a black disc surrounded by an aureola of limited extent, projected on the blue ground of the sky. On interposing an opaque body before the disc the aureola was seen better but always limited, and the pure blue sky terminated the same, which extended to rather more than half the solar radius; with the naked eye it was difficult to judge if the aureola was of equal breadth all round the disc, and the only thing well marked was the difference from the view obtained at the level of the sea; while the sky is ordinarily whitish about the sun, on Etna it remained blue, and the aureola acquired a better-defined contour. With a helioscope the aureola was much better seen, and its border appeared irregular, and as though it were rather more extended at four points, which, at noon, corresponded to the extremities of the vertical and horizontal diameters of the disc. At 3 P.M., after interruption from clouds which in passing rapidly at short intervals produced a striking effect by the formation of a stupendous series of coloured rings round the sun containing all the gradations of colour in the spectrum, a phenomenon new to Prof. Tacchini, the Tauber-spectroscope was applied to the telescope for examination of the solar spectrum, and the observer expresses his surprise at the fine definition of the lines and the extraordinary distinctness of the whole; the chromosphere was bright.

In the evening at 10h., the spectacle of the starlit sky was novel and enchanting. Sirius appeared to rival Venus, the finer constellations acquired an altogether special aspect, and the appearance of the Via Lactea was astounding. The image of the planet Saturn was admirable, and the peculiarities of the ring and belts were seen to much greater advantage than at Palermo, shortly before leaving. Venus afforded remarkable proof of the rare quality of the sky of Etna. The planet shone with a powerful light, which cast shadows during the ascent of the mountain; it scintillated frequently like a star. The telescope showed, on the northern part of the phase, an oblong space, less illuminated than the rest of the disc, which Prof. Tacchini says was "sicuramente una macchia del pianeta."

Spectroscopic observations were renewed on the following morning, when the sun had attained an altitude of 10°. The chromosphere was "magnificent;" the inversion of the magnesium and of 1474 was immediately evident, which was not seen at Palermo with the same telescope.

With regard to the proposed observatory which Prof. Tacchini is desirous should be an accomplished fact before the meeting of the scientific bodies at Rome, in September next, he proposes that it should be erected at the *Casina degl' Inglesi*, and should be named after Bellini, and that it should belong to the University of Catania. He suggests that it ought to be provided with a refractor of first-rate quality and of at least 16 centim. (about 6·3 inches) aperture, and he advises that while the meteorological instruments, which should be adapted to the requirements of the day, as indicated by the London Congress, would remain constantly at the Bellini Observatory, a duplicate mounting might be provided for the refractor at some spot within the University of Catania, with its proper dome, the other being fixed on Etna, so that while from June to the end of September astronomical observations could be carried on upon the mountain, during the winter they might be made at Catania, where the sky is a very good one; the astronomer would thus have only the object-glass with its tube to transport to and fro. Prof. Tacchini further suggests that accommodation for visitors should be provided, with the view to increasing their numbers, and that a certain payment should be made by them, to go towards the maintenance of the Observatory and its custodian.

We wish every success to the scheme thus energetically brought before the Italian authorities by Prof. Tacchini, and have no hesitation in predicting important gains to science from its adoption.

THE NEW STAR OF 1604.—The vicinity of this star's place deserves to be closely watched, as it appears by no means improbable that the object may be identified amongst the telescopic stars actually visible, by small fluctuations of brightness, which there are grounds for supposing to have been the case with the so-called new stars of Tycho Brahe and Anthelm.

The best position of Nova 1604, is no doubt that deduced by Prof. Schönfeld from the observations of David Fabricius, found in the *literæ mutuæ* in Fritsch's edition of Kepler's works. Fabricius measured the distance of the new star from ζ, η, α Ophiuchi, α Aquilæ, and α Scorpii, and the discussion of these measures leads to the following place for 1605·0, R.A. 256° 45′ 43″ or 17h. 7m. 2·9s., N.P.D. 111° 4′ 42″, with probable errors of ± 2·0s. and ± 0·65′; this position brought up to 1877·0 is R.A. 17h. 23m. 16s., N.P.D. 111° 22·4′. The nearest catalogued star is one of 8·9 mag. observed in Argelander's Southern Zones, No. 16872 of Oeltzen's reductions. Kepler's star precedes, according to Schönfeld's calculation, 25·3s., and is N. about 0·8′. There is a star 12·13 mag. preceding Argelander's star 18·8s. and 1·6′ to the south, suspiciously close to the recorded place, since the probable errors are no safe guide in such a case as this. Chacornac on Chart No. 52, has a tenth magnitude in about R.A. 17h. 21m. 50s., N.P.D. 111° 22′ for 1855, which is not now visible or was not last summer. But the locality requires a stricter and more systematic examination, which may be suggested to some one of our astronomical readers, who possesses adequate optical power, when this region of the sky is favourably situated for observation.

METEOROLOGICAL NOTES

Storms and Floods of the Past Six Weeks.—An examination of the Daily Weather Maps published in different countries of Europe for this period is very instructive. The most common course taken by the winter storms of north-western Europe is an easterly or north-easterly one, and the tracks of their centres lie somewhere between Farö and Iceland. Hence the winter climate of the British Isles is characterised by south-westerly winds, and the relatively high temperature and humidity which they bring with them from the Atlantic. This state of things is occasionally varied by the centre of the storm passing in its easterly course across England, along the Channel, or over a track even still further south, resulting in easterly and northerly winds at places situated to the north of the centre track, with the probable accompaniments of sleet, snow, or hail, low temperatures, chill drizzling rains, and heavy seas. Since, however, the storm-centres usually soon pass on to eastward, the easterly winds accompanying them are generally not of long continuance. But during these past six weeks, notably from December 1 to 7, 16 to 24, and 31 to January 7, the cyclonic centres have had their course in the south, or to the south, of the British Islands, and consequently easterly and northerly winds have prevailed, particularly in the north of Great Britain. The cyclonic centres, instead of advancing, as ordinarily happens, to eastward, oscillated backwards and forwards—to eastward and then to westward, to north-westward, and then to south-eastward—being thus continually for days together in the south of the British Islands, and hence the persistency of the easterly winds for several days in succession in the north. Finally, since steep gradients prevailed frequently and for considerable periods from North Britain to Norway, the easterly winds acquired a violence, as well as a persistency, almost unprecedented, strewing the coasts with wrecks, and raising high tempestuous seas, which, particularly when conjoined with the high tides in the beginning of January, damaged harbours and other property to an extent fortunately of rare occurrence in these islands. As frequently happens, gradients were also steep and winds violent over the Channel and the south of England. The snow and rainfalls were also excessive, and blocking up of railways and river floodings, with the inconveniences and disasters attending them, were experienced in all parts except the north-west of Great Britain. At many places the rainfall of December was the heaviest ever recorded. The intimate bearing of the weather of Scandinavia and Lapland on that of Great Britain, and its great scientific importance in forecasting British weather—a point we have on various occasions insisted on in this journal—were several times conspicuously illustrated during the singular weather of these six weeks.

Physics of the Atlantic Ocean.—Dr. Buys Ballot has made a valuable contribution to the physics of the Atlantic Ocean in a paper just published on its mean monthly atmospheric pressure. The author wisely groups the observations for each degree of latitude along the outward and homeward bound routes of the Dutch ships on board which the observations were made. The extent and laboriousness of the work will be understood from the fact that for the North Atlantic alone, 175,003 observations have been discussed for the outward, and 163,418 for the homeward bound route. We shall take an early opportunity of reverting to the subject of this paper; in the meantime we content ourselves with heartily recommending the paper more particularly to seamen, from its great utility in navigation, seeing that it gives them the average barometric pressure each month for each degree along this great highway of commerce, which, when intelligently interpreted by the wind which happens to prevail at the time, puts them in possession of information, the importance of which it is impossible to over-estimate.

Weather Maps of Germany.—The Weather Maps of the *Deutsche Seewarte*, in the numbers for January, already received, give on a large scale the barometric curve and the hourly direction and force of the wind for the twenty-four hours previous, as recorded by the self-registering instruments at Hamburg. The value of such data in the study of the daily changes of the weather it is unnecessary to point out. This Office has also begun to publish monthly *résumés* of the weather of the Continent, of which those for January and February, 1876, have appeared, containing short papers by various well-known meteorologists, referring to the weather of the month; and the averages and extremes for the month are briefly but lucidly discussed for all the stations in Germany, and for many other stations in the countries adjoining. A valuable chart is given showing the tracks from day to day of all the European storms of the month.

Thunderstorms in Central Europe.—It was recently shown by M. von Bezold that there is a double maximum in the frequency of summer thunderstorms in particular regions of central Europe. The results of further researches by others seem to point in many cases to a similar behaviour in hydrometeors generally. Thus a double periodicity in hailfall has been demonstrated by M. Prettner for Kärnthen and M. Fournet for the Rhone Valley. And more recently still (*Pogg. Ann.*), Dr. Hellman, having studied the rainfall in North Germany, is led to the following conclusions:—1. There is a double maximum in both the frequency and quantity of rain in the summer months in North Germany. 2. The first maximum falls, in the case of quantity of rain, in the beginning of the second half of June; that for frequency of rain in the beginning of June; the second maximum for both cases in the middle of August. 3. The first maximum is more intense in the case of frequency of rain, and weaker in the case of quantity. Dr. Hellmann offers an explanation of these phenomena, for which, however, we must refer to the original.

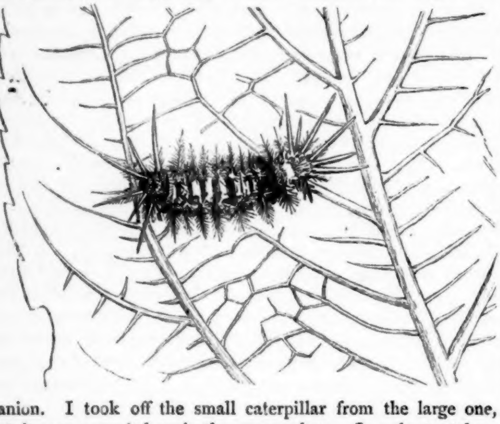
Sunspots and Weather.—Prof. Fritz, of Zurich, has shown from a comparison of annual meteorological statistics, that the years distinguished by a maximum of solar spots coincide very closely with those years marked by exceptionally severe hailstorms, and an unusual average height of the great rivers. This law is shown to be in accordance with observations made during the past century in all latitudes, the special periods occurring at intervals of eleven years.

BIOLOGICAL NOTES

Chemical Changes Observed during Progress of the Potato Disease.—The Rev. J. H. Jellett details the results of a series of experiments made to ascertain (1) whether there be any development of sugar during the progresss of the disease, and if so of what kind? (2) whether there be any perceptible change in the quantity of nitrogen? It would appear that the first stage of the disease in the tuber is marked by an increase in the quantity of the nitrogen, which seems to attain its greatest value before the stage of discoloration of the tuber. The same stage of the disease is also marked by the development of sugar, both glucose and sucrose. In the second stage of the disease, marked by a great increase in the discoloured part of the tuber, the part which remains apparently sound shows no increase of nitrogen, but a very considerable increase in the quantity of sugar, while in the discoloured part there is a diminution both in the percentage of nitrogen and of sugar. It will be remarked that the development of the sugar continues for a considerable time after the nitrogen has attained its maximum value. Mr. Jellett has no doubt that the whole of this sugar is formed by the conversion of the potato starch, though he is not aware that there is any known method by which starch can be made to pass into sucrose; possibly this effect may

be produced by the presence of the fungus. (*Proc. R. Irish Acad.*, Vol. ii., Series ii. Science, January, 1877.)

Commensalism among Caterpillars.—The following extract from a letter from Fritz Müller, dated Itajahy, Brazil, October 22, has been sent us by his brother, Dr. Hermann Müller, of Lippstadt:—"I have lately become acquainted with an interesting case of commensalism in two caterpillars, of which I inclose a photograph taken by my friend, Scheidemantel. The larger caterpillar, with red head, protected by long branchy stinging-hairs or thorns, lives on mulberry and other trees. Like other caterpillars protected from enemies by odour, stinging-hairs, or otherwise, it sits on the upper side of the leaves, and is light-coloured, the head red, the hairs white. Across its back, between its thorns, there sits a small blackish caterpillar, protecting itself by the thorns of the large companion.



I took off the small caterpillar from the large one, but it soon occupied again the same place. In order to take a photograph of it, the larger caterpillar was anæsthetised with ether; it recovered again somewhat, but after two days it died. The smaller caterpillar has now left its place and taken refuge on another caterpillar in the same box; on this it sits somewhat further forward, on the base of the abdomen. In its former host, the place where the small caterpillar sat looks pale, as if it had been scoured. The small caterpillar from above eats small holes in the leaf on which the larger one is sitting. As far as I know, no similar case has hitherto been observed."

Blistering Beetles as a Cure for Hydrophobia.—M. de Saulcy, père, laid before a late meeting of the Entomological Society of France the *débris* of two species of beetles belonging to the Meloidæ (*Meloë tuccius* and *Mylabris tenebrosa*) which had been sent to him from Gabès, in Tunis, by M. de Chevarier, and which constituted the medicine in use by the people of Amerna as a cure for hydrophobia. It is known under the name of *Dernona*, and is mentioned in several Arabian works on medicine. A portion about the weight of a grain of corn is given to the sufferer. The medical formula directs that it should be taken in some meat soup by the person bitten between the 21st and 27th day after the bite; if taken before or after these dates it will not effect a cure. The natives of Amerna seem to have great faith in this cure, and preserve the dried beetles as a treasure. It might be worth while to try a series of experiments on the use of the vesicating beetles in this terrible malady. But it should not be forgotten that so long ago as 1750, Linnæus, in his dissertation, "De Materia Medica in Regno Animali,' suggested the employment in such cases of the common blistering beetle, and in 1856, when M. L. Fairmaire laid before the Entomological Society of France a brochure by M. Saint Hombourg on the treatment of hydrophobia by the administration of a species of Meloë, many of the members then present mentioned that this remedy was known for a very long time in Germany. (*Ann. Soc. Ent. France*, 27 Dec., 1875, *Bulletin*, p. clxiii.)

Carboniferous Amphibia in Nova Scotia.—In the Carboniferous era many of the Sigillarian trees became partly embedded, and as they decayed their inner bark and woody axes crumbled away, leaving open holes on the surface of the ground into which were swept by water, or fell accidentally, the animals of the period together with vegetable *débris*. In this way successive layers of deposit, within the trunks of the trees, became stored with skeletons of Amphibian animals, snails, &c., which they have retained in an admirable state of preservation. Dr. J. W. Dawson, whose former investigations on this subject are well known by all palæontologists, has recently examined a fresh tree-stump about 2 feet high and 18 inches in diameter. In its interior were found no less than thirteen skeletons, more or less complete, belonging to six species, including *Hylerpeton dawsoni*, *Dendrerpeton acadianum*, *D. oweni*, a new species of *Hylerpeton* and *Hylonomus lyelli*. In the last part of the *American Journal of Science and Art*, Dr. Dawson has described these remains.

Action of the Brain.—At a recent *séance* of the French Academy, MM. Giacomini and Mosso presented the photograph of a woman who, from a syphilitic affection of the cranial walls, had lost a great part of the frontal and the two parietal bones. The movements of the brain of this woman (who is now completely cured) had been studied by the graphic method, one of M. Marey's tambours having been applied at the cranial aperture, and some remarkable results were obtained. The traces, which will appear in the *Archivio delle Science mediche*, prove that there are in the brain of man, even during the most absolute repose, three different kinds of movement:—1. *Pulsations*, which are produced at each contraction of the heart; 2. *Oscillations*, which correspond to the movements of the respiration; 3. *Undulations*, which are the largest curves, and are due to movements of the vessels during attention, cerebral activity, sleep, and other causes unknown; they might be called *spontaneous* movements of the vessels. The authors studied the relations between the movements of the brain, the heart contractions, the changes of volume of the forearm and the respiratory movements, by applying simultaneously with the arrangement just described, a pneumograph to the chest, and one of M. Mosso's plethysmographs to the forearm. The form of the brain-pulsation differs considerably from the tracing obtained from the fore-arm, or by means of a sphygmograph applied to an artery. During profound sleep, with snoring, there is considerable increase in the height of the cerebral pulsations, and the respiratory oscillations and the undulations are much more pronounced. Certain causes produce the same change of volume in the brain and in the extremities; others produce variations which are simultaneously in opposition in the brain and in the different parts of the body. The authors describe the effects of compressing the carotid and the jugular, the influence of bodily movements and intellectual labour, which are always reflected in a change of volume of the brain and therefore of its pulsations, and a number of interesting facts are elicited.

Papuan Plants.—So much still remains to be learned regarding the natural productions of New Guinea, that Baron von Mueller's Descriptive Notes on Papuan Plants, will contain much that is new to all botanists. Three successive papers have now been published under this title, the material being chiefly derived from the explorations of Macfarlane, Goldie, and D'Albertis. Von Mueller hopes that one or other of these energetic discoverers will shortly reach the hitherto unknown Alpine heights, which are likely to yield rich stores of endemic species.

NEST-BUILDING FISH.—The habits of those few fishes which build nests for their progeny are very curious, and indicate a highly-developed instinct. One of these, the Gourami (*Asphronemus olfax*), has lately been studied by M. Carbonnier in his private aquarium. The male animal constructs a nest of froth of considerable size, 15 to 18 centimetres horizontal diameter and 10 to 12 centimetres height. He prepares the bubbles in the air (which he sucks in and then expels), strengthening them with mucous matter from his mouth, and brings them into the nest. Sometimes the buccal secretion will fail him, whereupon he goes to the bottom in search of some confervæ, which he sucks and bites for a little, in order to stimulate the act of secretion. The nest got ready, the female is induced to enter. Not less curious is the way in which the male brings the eggs from the bottom into the nest. He seems unable to bring them up in his mouth; instead of this, he first takes in an abundant supply of air, then descending, he places himself under the eggs, and all at once, by a violent contraction of the muscles in the interior of the mouth and pharynx, he forces out the air he had accumulated, by his gills. This air, finely divided or pulverised, in some sort, by the lamellæ and fringes of the gills, escapes in the form of two jets of veritable gaseous powder, which envelops the eggs and raises them to the surface. In this manœuvre, M. Carbonnier says, the Gourami quite disappeared in a kind of air-mist, and when this had dissipated, he reappeared with a multitude of air-bubbles like little pearls, clinging all over his body.

BEAVER IN SIBERIA.—The beaver which, some centuries ago, was so numerous in Russia and Western Siberia, and which was supposed to have totally disappeared from both countries, continues to exist on the rivulet Pelyin. M. Poliakoff has procured from an ostyack on the Obi five skins of these animals killed last year, and he has engaged a hunter to procure this winter complete specimens for the Museum of the St. Petersburg Academy. No farther back than a century ago the beaver was common on one of the affluents of the Irtysh, Bobrofka, but it has now totally disappeared from the locality, the last colony existing probably on the Pelyin.

NOTES

THE first volume of "China," by the well-known geologist Baron von Richthofen, has just appeared. The Berlin Academy of Sciences has granted a generous sum to defray the expense of publishing this costly work.

WE have pleasure in announcing that a new Natural History Journal is about to be started, which is intended to form a bond of union among the various schools belonging to the Society of Friends in this country, both those for boys and girls. Some of the oldest societies of the kind in the country are in connection with these schools, especially the one at York, to which reference has more than once been made in these columns. The journal is intended to be specially devoted to young beginners; the main object being to awaken a personal interest in natural history pursuits, and to induce tyros to make and *record* observations. By this means it is hoped to promote a genuine study in place of the indiscriminate collecting now so much in vogue. Other cognate subjects will also be taken up as space permits, such as chemistry, carpentry, &c. It is intended to publish the first number on February 15; communications, which are warmly invited, should be addressed to J. E. Clark, B.Sc., 20, Bootham, York.

UNDER the title of the "Indian Miscellany," a work is announced by Mr. J. Munsell, of Albany, New York, on the history, arts, inventions, languages, religions, traditions, and superstitions of the American aborigines; with descriptions of their domestic life, manners, customs, traits, governments, wars, treaties, amusements, exploits, &c.; together with sketches of travel and exploration in the Indian country, incidents of border warfare, journals of military expeditions, narratives of captivity, anecdotes of pioneer adventure, missionary relations, &c.

M. ED. BECQUEREL has been elected president of the French Physical Society, which seems, like its English sister society, to be doing excellent work.

THE Council of the Geographical Society of Paris has appointed M. Levasseur president for 1877. MM. Daubrée and Quatrefages have been appointed vice-presidents, and M. Maunoir has been continued general secretary.

IT is stated on good authority that the measurement of the photographs taken by the French parties during the transit of Venus is not progressing favourably. More than 1,000 plates are to be investigated micrographically, and at the present moment only forty-seven have been disposed of. Unforeseen difficulties are said to have arisen.

IN 1828 M. Janson de Sailly, a French barrister who had married a sister of the celebrated Berryer, left by will his fortune to the French University, under the condition of creating a high school in the Quartier des Champs Elysées, to be named Janson College. The will was accepted by the Government, but the heirs tried to get it cancelled, and a law-suit was instituted, which was ended only in December, 1876. The Janson College will be inaugurated in 1878. The legacy is quite adequate to carry out the purpose of the testator, who was proprietor of the greatest part of a large estate.

GERMAN educational statistics show that in Saxony one out of 1,194 of the total male population is in actual attendance upon a university, while in Prussia the proportion is 1 io 1,328.

THE next annual meeting of the *Deutsche geologische Gesellschaft* takes place at Vienna, in September of this year.

THE Council of the Society of Arts have made arrangements for the delivery of six lectures on various scientific subjects, which will take the place of the usual papers and discussions, on six Wednesday evenings during the session. The following gentlemen have each consented to deliver one of the lectures:—Sir John Lubbock, Bart., F.R.S., Mr. E. J. Reed, C.B., M.P., Prof. W. K. Clifford, M.A., F.R.S., Prof. Alexander Kennedy, C.E., Dr. B. W. Richardson, F.R.S., Mr. James Baillie Hamilton.

THE Bremen Geographical Society has received a report from Capt. Wiggins dated Jenissei, November 25, in which he gives more fully the results of his late voyage to Siberia. The Podaratta Bay was found to be exceedingly shallow, and the river itself could not be ascended by craft drawing over two feet of water. Special stress is laid upon the discovery of the channel for sea-going vessels up the picturesque Jenissei as far as Kureika. Numerous observations of the temperature of the air and water, the specific gravity of the latter, &c., were taken during the progress of the voyage. These all tend to show that the Gulf Stream and equatorial currents exert a decided influence much farther to the east than was hitherto supposed, as they pass through the straits of Jugor and Waigat into the Karian Sea.

THE adherence of air round a current of some fluid or liquid when this is forced through the air, has been utilised in various ways, as in water bellows, the blast pipe of locomotives, Sprengel's air-pump, the Bunsen burner, &c. Prof. Teclu, of Vienna, has recently described, in *Poggendorff's Annalen*, a simple arrangement, in which a jet of steam is used to do the work of an air-pump. A small steam boiler containing 1·5 litres of water, and tested to something over one atmosphere, is heated over a gas furnace. It has a safety-valve, which also serves for admission of water when necessary. From above rises a brass steam pipe

consisting of two similar parts, each of which is a tube narrowing upwards; the terminal aperture of the lower tube (*a*) is situated just where the contraction of the upper tube (*b*) terminates, leaving a small annular aperture. Two lateral tubes proceed from the wide portion of the upper tube, one to the vessel to be exhausted, the other to a manometer. It will be seen that the steam issuing from the boiler exerts suction on the air in the connected vessels.

AT a meeting of the Edinburgh Botanical Society, held on January 11, Mr. M'Nab made a second communication on the scarcity of holly berries at Christmas. He has learned from correspondents in various parts of the kingdom that the scarcity of holly berries has been very general. The only places where the supply of berries has been abundant are in the Highlands, in such districts as the Trossachs, and in the vicinity of Loch Katrine and Loch Ard. At Ranelagh, near Dublin, few berries were to be obtained, but several of the trees were covered with clusters of white and cream-coloured flowers, and it is of interest to note that all the flowers, both open and past, of the specimens received by Mr. M'Nab from Ranelagh, were hermaphrodite.

AT a meeting of the Glasgow Philosophical Society, held on Wednesday, January 10, it was agreed, on the motion of Sir William Thomson, to petition both houses of Parliament for the amendment of the Patent Laws, the objects aimed at being the reduction of the stamp duty on patents, an extension of the time for which patents were granted, and the abolition in connection with the notice to proceed.

AT the second meeting of the Edinburgh Naturalists' Field Club, which was held on Friday last, a lecture on "Foraminifera," copiously illustrated by diagrams and microscopical preparations, was delivered by Mr. D'Arcy W. Thompson, a pupil of the present seventh class of the Edinburgh Academy. Science lectures *by* schoolboys are a much rarer occurrence than science lectures *to* them.

IN a note to the Roman Academy on the rate of oratorial utterance, M. Mariotti recalls an observation made by Gibbon that a facile English orator pronounced 7,200 words in an hour, *i.e.*, 120 in a minute, and two in a second. Though it might seem possible to investigate the velocity of the Greek and Roman orators, knowing that the judicial orations in Athens were recited in a space of time determined by the clepsydra, yet their methods render conjecture somewhat vague. Thus, *e.g.*, it is said that Caius Gracchus, when speaking in the forum, had a servant concealed behind him, who, with an ivory instrument, signalled to him at the proper moments to raise or to lower his voice. Nowadays, when parliamentary discussions, as has been said, are little more than animated conversations, accurate observations may be made by means of stenography on the rate of speaking of various orators. M. Mariotti gives some such data from the Sub-Alpine and Italian Parliaments. De Foresta pronounced sixty words in a minute; Massimo d'Azaglio, 90; Gioberti, 100; Ratazzi, 150; Mameli, 180; Cordova, the quickest, was able to pronounce as many as 210. The very rapid orators, M. Mariotti says, are rather admired than effective, such as Macaulay in England, and Cordova in Italy. The mind of the hearer is not allowed sufficient time to take in the meaning. It is possible, speaking rapidly in the Italian tongue, to pronounce 300 words in a minute. Comparative observations on the subject in parliaments of different countries, would afford important data regarding various tongues, and suggest interesting psychological considerations. From observations in the Parliament of Athens, it might be possible to conjecture the velocity of the ancient Greek orators. In this way stenography might render valuable services to philology and philosophy.

WE notice in the January number of the *Geological Magazine* a paper by Mr. James Durham on "The 'Kames' in the Neighbourhood of Newport, Fife, N.B.," accompanied by a sketch-map of the locality. Unhappily, the paper is written much in the same style as too many papers on kames have already been written, and we find in it, as is too often the case, more generalisations than thorough descriptions of the interior structure of these interesting formations, and not even a single detailed section. It gives us an opportunity, however, of observing that only thorough explorations of the structure of those kames the interior of which is rendered accessible by adequate cuttings, together with detailed studies of the directions, positions, and forms of the kames, discussed in connection with the topography of the locality and its neighbourhood, can help us to settle the question as to the origin of kames, so much debated hitherto without arriving at any definitive result. As to the conclusions of the author, viz., that "the kames" owe their present forms to the same denuding agencies as are at present in operation, we must object that, even if the author had proved his statement with reference to the Newport kames, he was by no means entitled to generalise from it; there are hundreds of kames and thousands of totally identical gravelly mounds and ridges the shapes of which have nothing to do with denuding agencies.

THE first number of the *Veröffentlichungen des kaiserlichen deutschen Gesundheitsamtes*, appeared last week. It gives the mortality statistics of about 150 German cities and a large number of foreign cities, and supplies a most valuable picture of the progress of epidemics as well as the general statistics of disease, and the working of all sanitary regulations at home and abroad. A graphic representation of the meteorology of the past week is also added.

VERY high floods, second only to those of 1872, are reported, by Russian newspapers, from the shores of the Amoor. After unusually heavy rains, which fell almost without interruption from the middle of July until the end of August, the waters of the great river rose so as to menace even Blagovieshensk, built on a comparatively high bank, and overflowed the villages and fields of the Upper and Middle Amoor. A very heavy gale visited also the Lower Amoor on the night of September 18 and 19. Some barges were destroyed, a steamer was much damaged, and some houses on the shore at Khabarofka were washed away.

THE rain which fell at St. Jaen, in the Côtes-du-Nord, on the night of December 29-30, 1876, was observed to be tinged red. A bottle filled with the water has been sent to Dinant to be analysed microscopically and chemically.

THE French Government is selling by auction the last four balloons which were constructed during the siege for escaping from Paris. These balloons are considered unfit for service, and others will be constructed by the balloon committee, a credit of 200,000 francs having been placed in the budget of 1877 for military ballooning.

NEWS has been received from the *Frigorific*, which has arrived with its cargo of meat at La Plata, where experiments have been continued on the largest scale. The success is complete.

THE Paris-Lyons-Mediterranean Railway Company have ordered sixty locomotives to be constructed, which are intended to travel from Paris to Marseilles (1,820 kilometres) in twelve hours. The Northern Railway has established comparative experiments on the Westinghouse continuous brakes and electric brakes. The old hand-brakes are to be superseded at any cost by the Northern Railway.

PROF. MACH, of the Vienna Academy, has recently made some experiments on the velocity of propagation of sound-waves from explosion. He finds that in course of the motion this velocity diminishes, and soon approximates to the ordinary velocity

of sound. In one experiment, by means of a fall-apparatus with double hammers, two percussion caps were exploded (at a determinate interval) at the two ends of a tube. From the displacement of the interference-band on the inner smoked surface of the tube, the velocities were found to be more than 700 metres over a stretch of 50 centimetres. With weaker explosions or longer stretches, the velocities were less. Again, a pistol-ball, whose velocity was determined, liberated at two stations, at a measurable interval of time, two electric discharges. From the displacement of the interference-band, the velocity appeared to be about 400 metres. Several other experiments are described in Prof. Mach's paper.

MR. FREDERICK A. OBER has recently sailed from America for Martinique to commence an exploration of the West India Islands, under the patronage of the Smithsonian Institution. Mr. Ober proposes to begin at Martinique, and to collect the vertebrates on all the Leeward Islands, visiting each one in succession, and proceeding east and south by the Windward Islands to the Spanish Main. The work will probably occupy several years, and with it will be combined the taking of photographic views of the scenery and inhabitants. It is believed that, should Mr. Ober be as successful as he anticipates, a critical investigation of his collections by specialists will not only bring to light species long ago described and not met with for many years, but will include some new to science, and at the same time elucidate many interesting problems in physical and zoological geography.

MR. JOHN MURRAY has the following new works in the press:—"Scepticism in Geology, and the Reasons for it," by Verifier; "The Cradle of the Blue Nile," an account of a journey through the mountains of Abyssinia and the plains of Soudan, and a residence at the court of King John of Ethiopia, by E. A. De Cosson, F.R.G.S.; "Pioneering in South Brazil," a narrative of three years of forest and prairie life in Paranâ, by Th. P. Bigg Wither. These two last books will both be accompanied by maps and illustrations.

WE have the following books on our table:—"Winds of Doctrine," by Ch. Elam (Smith, Elder, and Co.); "Thebes and its Five Greater Temples," by Capt. Abney, F.R.S. (Sampson Low and Co.); "Animal Physiology," by Prof. McKendrick (Chambers); "The Two Americas," by Sir R. Lambart Price (Sampson Low and Co.); "The Discoveries of Prince Henry the Navigator," by R. H. Major (Sampson Low and Co.); "Darwiniana," by Prof. Asa Gray (Trübner); "Across the Vatna Jokull," by W. L. Watts (Longmans); Dr. Dobell's "Reports on Diseases of the Chest," vol. ii., 1876 (Smith, Elder, and Co.).

THE additions to the Zoological Society's Gardens during the past week include two Secretary Vultures (*Serpentarius reptilivorus*) from South Africa, presented by Capt. Larmer, of s.s. *African*; two Crowned Partridges (*Rollulus cristatus*) from Malacca, presented by Mr. Barclay Field; three Chukar Partridges (*Caccabis chukar*) from North-West India, presented by Capt. Newton Pauli; two Caroline Conures (*Conurus carolinensis*) from North America, presented by Mr. L. Delves Broughton; a Wood Owl (*Syrnium aluco*), European, presented by Mrs. A. O. Faulkner.

SCIENTIFIC SERIALS

THE *American Journal of Science and Arts*, December, 1876.—Experiments on the nature of the force involved in Crookes's radiometer, by O. N. Rood.—Experiments on the sympathetic resonance of tuning-forks, by Robert Spice.—Types of orographic structure, by J. W. Powell.—On the ethers of uric acid, by H. B. Hill.—Notice of a meteorite from Madison Co., N.C., by B. S. Burton.—On a recent discovery of carboniferous Batrachians in Nova Scotia, by J. W. Dawson.—On the association of crystals of quartz and calcite in parallel position, as observed on a specimen from the Yellowstone Park, by Edward S. Dana.—Principal characters of the American Pterodactyls, by O. C. Marsh.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, January 11.—Mr. S. Roberts, treasurer, in the chair.—Mr. G. W. von Tunzelmann was elected a member.—The following communications were made to the Society:—Determinant conditions for curves, or surfaces, of the same order, having all their intersections common, by Mr. J. Hammond.—Numerical values of the first twelve powers of π, of their reciprocals, and of certain other related quantities, by Mr. J. W. L. Glaisher, F.R.S.—On some general classes of multiple definite integrals, by Mr. E. B. Elliott.—On the partial differential $s + Pp + Qq + Z = 0$, by Prof. H. W. Lloyd Tanner.—Determination of the axes of a conic in tri-linear co-ordinates, by Mr. J. J. Walker.—On some elliptic-function properties, by Prof. H. J. S. Smith, F.R.S.

Linnean Society, December 21, 1876.—Prof. Allman, president, in the chair.—Mr. Thomas Christy and Mr. Robert Drane were balloted for and duly elected Fellows of the Society.—The butterflies of Malacca, formed the subject of a paper by Mr. A. G. Butler. Of 258 species now registered from Malacca thirty-six are endemic; of the remainder sixty-five also belong to Assam or Nepal, thirty-eight to Moulmein, thirty-three to Ceylon, ninety-four to Penang, forty-six to Singapore, 112 to Borneo, forty-one to Sumatra, eighty-seven to Java, thirty-nine to Siam, twenty-six to China, two to New Hebrides, and six to Australia. Thus the Malaccan butterflies preponderate towards those of the Indian region. For several reasons, however, the so-called Penang fauna must be accepted with considerable qualifications.—A communication was read from Mr. J. R. Jackson on the commercial uses of a species of cane termed "Whangee." This was shown to be a species of *Phyllostachys*, possibly *P. nigra*, and supposed to be from China. That common in the trade he considers not to be the stem proper but the rhizome; pale-coloured, as introduced, plants of the kind in question grown in England produce a black cane, hence bleaching must be resorted to with the commercial sort.—*Craniorrhinus waldeni* is the name of a new Hornbill from the Island of Panay (Philippines), described by Mr. R. B. Sharpe. It is allied to *C. cassidix*. The new species was found by Prof. Steere in a virgin forest in the mountainous range of the island.—An extract of a letter from Dr. J. Anderson, of Calcutta, was read. It mentioned some curious facts in connection with the Hornbills *Hydrocissa albirostris* and *Aceros subruficollis*. These birds greedily devour, head foremost, the smaller kinds of the feathered tribe, and before doing so break all the bones of the bodies and toss the bird about.—The Secretary read some morphological notes on certain species of *Thunbergia*, by Mr. Marcus Hartog. He states that microscopical sections of *T. laurifolia* reveal axillary buds inside the sixth and eighth pair of bracts, the basal elevations becoming pedicel and bractlets, and inside these, by repetition, sister buds arise. The flowers are thus axillary buds formed in succession from the axis outwards and are as independent as if they had arisen side by side.—Dr. Buchanan White brought forward a paper on the male genital armature in the European Rhopalocera. His researches yield evidence that as in some other orders of the Insecta the appreciable structural variations of the organs in question afford good characters whereby to distinguish not only genera, but species, of the above limited group of Lepidoptera.—Prof. Flower communicated a memoir on the morphology of mammalian *Ossicula auditus*, by Mr. A. G. H. Doran. While dealing with these diminutive bones *in extenso*, the author more particularly confined his summary to those of the Insectivora, Cheiroptera, Cetacea, Sirenia, Edentata, Marsupialia, and Monotremata. In the first of these groups the ossicula present no positive or marked characteristic. Among the bats there is a resemblance to what obtains in the shrews, except in the genus *Pteropus*, where the malleus is of a lower type. Of whales, *Balæna* has the most generalised type; the dolphins have relatively stout stapedial crura and other marked features; *Platanista* has slightly modified ossicula. Those of Sirenia are distinguished by weight and outline. Certain of the Edentata (armadillos) differ among themselves, and so do the sloths and ant-eaters, as far as concerns their internal ear-bones. Marsupials possess ossicula of a low grade still descending in the Monotremata. The general conclusion arrived at is that even by the so-to-say subsidiary differentiation of the auditory ossicles doubtful affinities in some cases receive a certain interpretation.—*Actæmorpha erosa* is the name given to a new genus and spe-

cies of crustacean described by Mr. E. J. Miers. It was dredged at seven fathoms, and came up along with a number of *Cancroidea*, &c., and which it resembles much, though structurally undoubtedly belonging to the family Leucosiidæ.—Mr. H. N. Moseley tendered a paper descriptive of two new and remarkable forms of deep-sea Ascidians obtained by him during the *Challenger* expedition. The first of these aberrant forms was trawled in the North Pacific, from a depth of 2,900 fathoms. This *Hybythius calycodes*, of cup-like shape, is probably allied to *Boltenia*, but differs, among other things, in possessing a series of cartilaginous plates developed with symmetrical arrangement on its otherwise soft test. The second Ascidian, named by the author, *Octacnemus bythius*, was got from 1,070 fathoms. Star-shaped, or of eight-rayed form, its gill-sac is nearly horizontal, and gill-network absent; muscular prolongations of the tunic run into the curious conical protuberances of the test; nucleus contracted and small like that of *Salpa*. This unique specimen, so far as our present knowledge goes, is presumed to be without living allies.

Anthropological Institute, January 9.—Col. A. Lane Fox, president, in the chair.—Mr. Henry Hyde Clarke exhibited a handsome feather dress from the Amazon.—Mr. Moseley, naturalist to the *Challenger* expedition, then read a long and most interesting account of the inhabitants of the Admiralty Islands. He considered that in their arts, as shown in the ornamentation of their weapons, &c., they resembled the natives of New Guinea, while in a peculiar note in their chants or singing he noticed a strong Fijian resemblance; their manner of hafting the stone implements differed from that in other groups, the stone being fixed in a slot in the wood. Obsidian spear and knife heads were shown, the mounting of the obsidian flakes in the spear heads being effected with a strong gum and twine. The lecturer described most fully the customs, dress, and manners of the natives, and gave some thirty-five words of the language. The whole was illustrated with maps, sketches, and numerous objects. The president and Prof. Rolleston took part in the discussion.—Mr. J. P. Harrison then read the report on recent excavations at Cissbury Camp. The pit that has been excavated immediately adjoins the one cleared out by Mr. E. Willett in 1874, and is of nearly the same size. There are two platforms, one above the other, in a kind of apse on the highest, or eastern side of the pit. Galleries radiate in all directions, excepting towards the west, where, under a mass of chalk rock which projects into the pit some six feet, there is a small chamber. Outside of it a quantity of charcoal and smoked chalk indicated that a fire had been made on the floor of the pit. Lines in different combinations were found at the entrances of two of the galleries and also on loose blocks of chalk; some of them may, perhaps, possess a definite meaning, but the majority were most probably idle marks.

PARIS

Academy of Sciences, January 3.—M. Peligot in the chair. The following papers were read:—Observations on a reclamation recently presented by M. Faye, with regard to whirlwinds produced in the atmosphere, by P. Secchi. The supposition of descending currents in whirlwinds is very old; we find it in Lucretius and the ancient physicists. Besides trombes with descending pressure, there are many which exert suction. M. Faye replied, denying the latter fact, maintaining the novelty of his ideas, &c.—Practical processes for the destruction of Phylloxera, by M. Boiteau. He describes an apparatus, a perforator with automatic distribution, employed in applying the insecticide liquid.—The programme of a prize founded by the late Dr. Bresca, was announced from the President of the Turin Academy of Sciences. It is 12,000 francs, and to be awarded every two years to Italian and foreign *savants* alternately, for the most brilliant and useful discovery or most remarkable work in the physical and experimental sciences, natural history, pure and applied mathematics, physiology, and pathology, not excluding geology, history, geography, and statistics. First award, in 1879, to a *savant* of any nationality.—The cyclic or logarithmic periods of the quadratrix of an algebraic curve of degree m are the products by $2\pi\sqrt{-1}$ of the roots of an algebraic equation of degree m, which may always be obtained, and the coefficients of which are rational functions of those of the equation of the curve proposed.—Theorem by M. Maximilien Marie.—On the cause of motion in the radiometer, by MM. Bertin and Garfe. In a suspended radiometer, according to the initial conditions, the movement of the vessel may be *nil*, positive, or negative, and thus may be explained various errors of observation. From the equation $I\omega + I'\omega' = \text{const.}$ (where I, I' are the moments of inertia of vessel and vane-system, $\omega\,\omega'$ their angular velocities), the authors draw several consequences which are verified by experiment.—On the flow of mercury by capillary tubes, by M. Villais. The quantity which flows in a second is proportional to the pressure under which the flow occurs, and to the fourth power of the radius of the tubes, and inversely proportional to the length of the tubes, if a certain minimum length have been passed which is smaller the narrower the tubes, and the less the pressure. For tubes with elliptic section, the minimum length under which these laws are no longer verified is smaller than for circular tubes whose radius is equal to the mean radius of the elliptical section. The quantity of flowing mercury, lastly, depends on a certain constant, which depends on the form of aperture of the tube and the nature of the sides.—On an experiment similar to that of singing flames, by M. Montenat. Into a long vertical metallic tube is lowered a metallic basket with glowing charcoal. When this has reached the lower part, the air-current produces a sound. On raising the charcoal towards the middle, the sounds increase, diminish, and cease; on continuing the movement they recur, but at the double octave of the first, and they cease as the charcoal nears the orifice.—M. Famin recalled M. Kastner's pyrophone.—On the rotatory power of mannite and its derivatives, by M. Bouchardat. Contrary to MM. Müntz and Aubin, who supposed manite to be a substance with indifferent rotatory power, it is shown to possess a real levogyre power near $-0^{\circ}\cdot 15'$.—Researches on Melezitose, by M. Villiers.—Remarks on this communication and on the constitution of the isomerous sugars of cane sugar, by M. Berthelot. The unison of two molecules of the same glucose, regarded in turn as aldehyde and as alcohol, produces three distinct types of isomeroussaccharoses. Of these three types mixed ether, mixed aldehyde, and ether aldehyde, the first and third alone are capable of reproducing third generations by simple hydratation, under the influence of acids or ferments.—Graphic study of the movements of the brain in man, by MM. Giacomini and Mosso.—On the alterations of quaternary deposits by atmospheric agents, by M. Vanden Broeck. Such alterations in the Paris valley permit of assimilating the red diluvium to the grey, a simple *facies* of modification of the same layer.—M. Virlet d'Aoust described a lunar halo observed by him at Paris on the 30th ult.

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